

Pump Test Report

NGK Metals Corporation
RCRA Corrective
Measures Implementation

Prepared for:

NGK Metals Corporation
P.O. Box 13367
Reading, PA 19612-3367

Prepared by:

RUST Environment & Infrastructure
Mechanicsburg, Pennsylvania

May, 1994

Volume 1

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AR360274



NGK Metals Corporation

Tuckerton Road P.O. Box 13367 Reading, PA 19612-3367 610 921-5000 Fax 610 921-5358

May 13, 1994

CERTIFIED MAIL/RETURN RECEIPT

Mr. Vernon Butler, RPM
Corrective Action RCRA Enforcement Section
U.S. Environmental Protection Agency
Region III
841 Chestnut Building
Philadelphia, PA 19107

Re: Initial Administrative Order
EPA Docket No. RCRA-III-01-CA
Pump Test Report

Dear Mr. Butler:

In accordance with the above referenced Administrative Order and your letter dated April 12, 1994 granting a 30 day extension, enclosed are four (4) copies of the Pump Test Report dated May 13, 1994 completed by RUST Environment & Infrastructure.

I certify that the information contained in or accompanying this letter is true, accurate, and complete. As to the portion of this submission for which I cannot personally verify its accuracy, I certify under penalty of law that this submission and all attachments were prepared in accordance with the procedures designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, or the immediate supervisor of such person(s), the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Sincerely,
NGK METALS CORPORATION

Lynne Woodside

Lynne Woodside
Supervisor, Environmental Affairs

cc: Mr. Frank Thomas
Mr. Charles Suenkonis



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AR360275



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1.0 EXECUTIVE SUMMARY

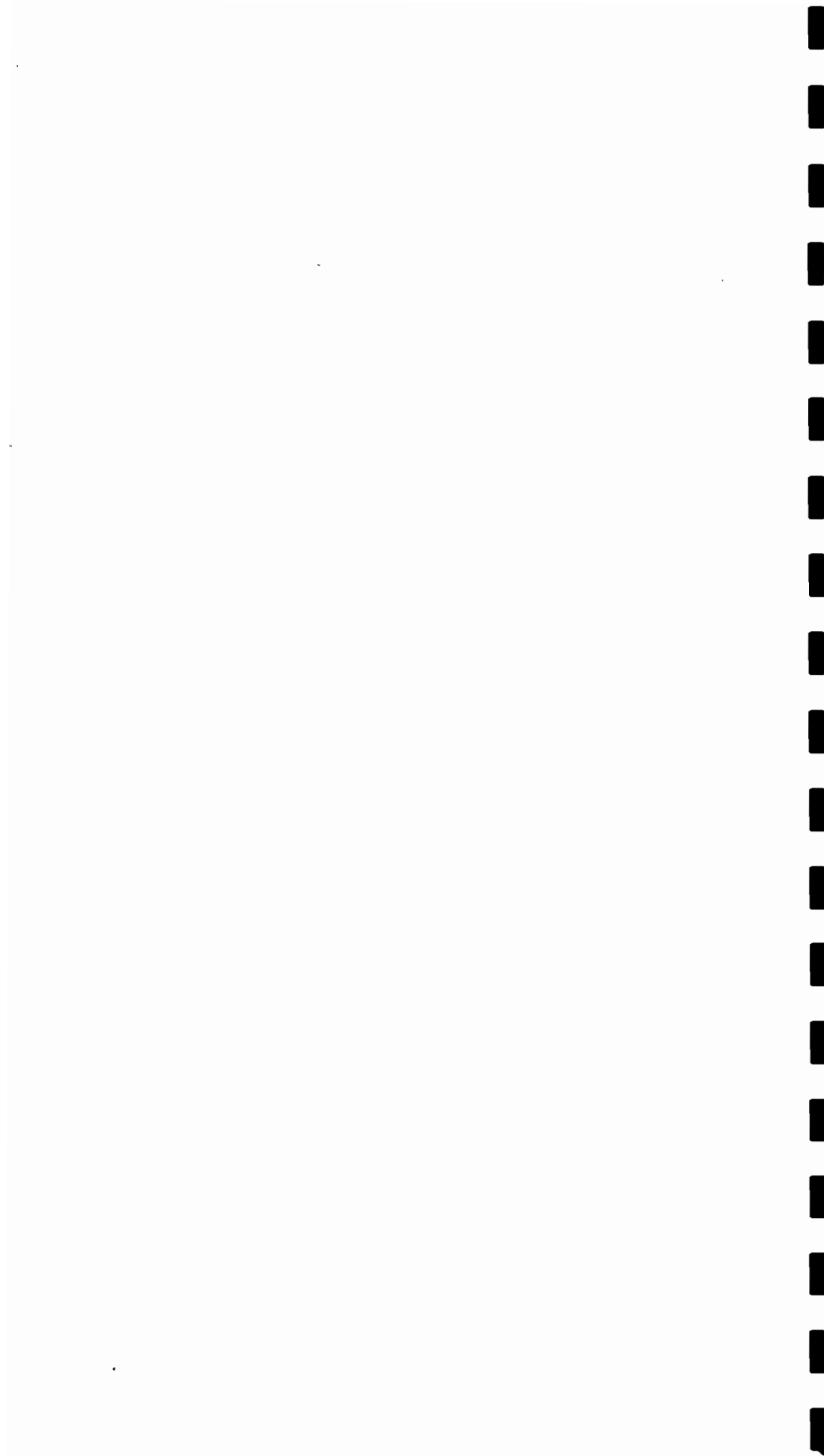
Between June 1993 and March, 1994, Rust Environment and Infrastructure (RUST) supervised the installation and construction of seven (7) new on-site monitor wells along with the completion of seven (7) drawdown/recovery tests. The new wells were installed, and drawdown/recovery tests performed to provide additional information in two primary locations of the site (the northeastern and west-southwestern corners), where hydraulic containment is necessary based on previous investigations. These activities were completed at the NGK Metals Corporation (NGK) facility in Reading, Pennsylvania as part of an EPA RCRA Facilities Investigation (RFI). The work was developed and performed in accordance with requirements established in the RCRA Record of Decision (ROD), and the Scope of Work for the Corrective Measures Implementation (CMI) Program.

Five (5) of the new wells were installed in the northeastern section of the site, and the remaining two (2) wells were installed along the western site boundary, for potential use as groundwater withdrawal wells. The location and design of each new well was based on the following information generated during previous site investigations:

- identified contaminant source areas;
- known groundwater flow directions;
- confirmed groundwater chemistry characteristics;
- aquifer characteristics determined by pump test results of three pre-existing monitor wells; and
- evaluation of the hydraulic behavior of aquifer materials proximal to and beneath the site through the use of a groundwater model.

Four (4) of the newly installed wells (DW-27, DW-28, DW-29 and DW-32) were pump tested, based on estimated yields of greater than five (5) gallons per minute (gpm) and location. Additionally, three (3) pre-existing wells located near the southwestern corner of the site (SW-8, DW-12 and DW-13) were pump tested and monitored along with selected observation wells for water level responses. The optimal flow rate at each of the pumped wells was determined by preliminary step-drawdown tests that preceded each of the pump tests. Each of the individual pump drawdown tests continued for a minimum of approximately 72 hours. The pump drawdown tests were of sufficient duration to result in measurable drawdown in monitor wells near the respective pumping well.

An evaluation of all drawdown testing completed to date is presented in Section 3 of this report. This evaluation, coupled with existing information, provides the basis for the preliminary design of the groundwater hydraulic containment system for the northeastern and southwestern portions



of the site, where hydraulic containment is necessary. Test results indicate that, initially, a groundwater hydraulic containment system consisting of wells DW-27 and DW-29 in the northeastern portion of the site along with wells DW-12 and DW-32 in the southwestern corner of the site would be effective in capturing groundwater that has been adversely impacted by previous industrial activities, and preventing the off-site migration of this groundwater.

Along the northeastern perimeter of the site, wells DW-27 and DW-29 will be sufficient to create drawdown zones (i.e. areas of capture) necessary to prevent off-site migration of groundwater. Pump test data suggest that the cumulative effect of pumping these wells will be overlapping cones of depression. Although groundwater chemical data suggest that overlapping cones of depression may not be necessary. Based on pump test data, it is estimated that a total groundwater withdrawal rate from wells DW-27 and DW-29 of about 100 to 130 gallons per minute will be needed to prevent migration of affected groundwater in the northern portion of the site.

Hydraulic containment is achievable along the southwestern perimeter of the site by pumping a combination of wells DW-12 and DW-32 with the possibility of later adding well SW-8. As an alternative, data also suggest that hydraulic containment will be achieved along the southwestern perimeter of the site by pumping a combination of wells DW-12 and DW-32 in conjunction with injection to wells DW-8 and DW-13. Actual pump test data collected from wells DW-12 and DW-32 suggest that overlapping cones of depression may develop after longer term pumping allows the groundwater system to fully achieve equilibrium. Development and maturation of the overlapping cones of depression will be enhanced by the installation of the remedial RCRA caps over the various past disposal areas. The resulting overlapping cones of depression would create a capture zone up to as much as 1000 to 1200 feet in length if pumped simultaneously (through the axis of pumping wells DW-12 and 32). Therefore, it is believed that the total groundwater withdrawal rate from the two wells would be about 150 gallons per minute. If, after long term pumping, the cones of depression do not overlap, then well SW-8 may need to be added to the hydraulic containment system either as a pumping well or injection well. However, if it is determined that well SW-8 needs to be added to the system, total withdrawal from wells DW-12 and 32 would likely be reduced to offset the increase if SW-8 is pumped.

The areas of influence (areas of capture) created by the pumping of these four wells will result in effective capture and containment of contaminated groundwater across the NGK site. The areas of influence, located across the northeastern and southeastern portions of the site are hydraulically downgradient of source areas. These areas of influence will intercept flow from principal areas exhibiting affected groundwater. Subsequent to the installation of the RCRA remedial caps and the hydraulic containment system, final groundwater configurations will change. As a result, the final configuration of the hydraulic containment system may need to be modified (addition or removal of extraction wells) to maximize effectiveness and provide an efficient hydraulic containment system.

A major factor affecting the final selection of the withdrawal wells is the potential limitations regarding final total discharge flow rates of treated groundwater. Treatment and disposal of the



groundwater is a major concern due to discharge limitations at Laurel Run. Therefore, it is imperative that the selected well achieve effective hydraulic containment (i.e. extensive areas of capture) using minimum withdrawal rates.

2.0 INTRODUCTION

RUST (formerly DUNN) has prepared several reports associated with the NGK Metals Corporation RFI. The principal documents that present details of the site-specific geology, hydrogeology and groundwater chemistry include:

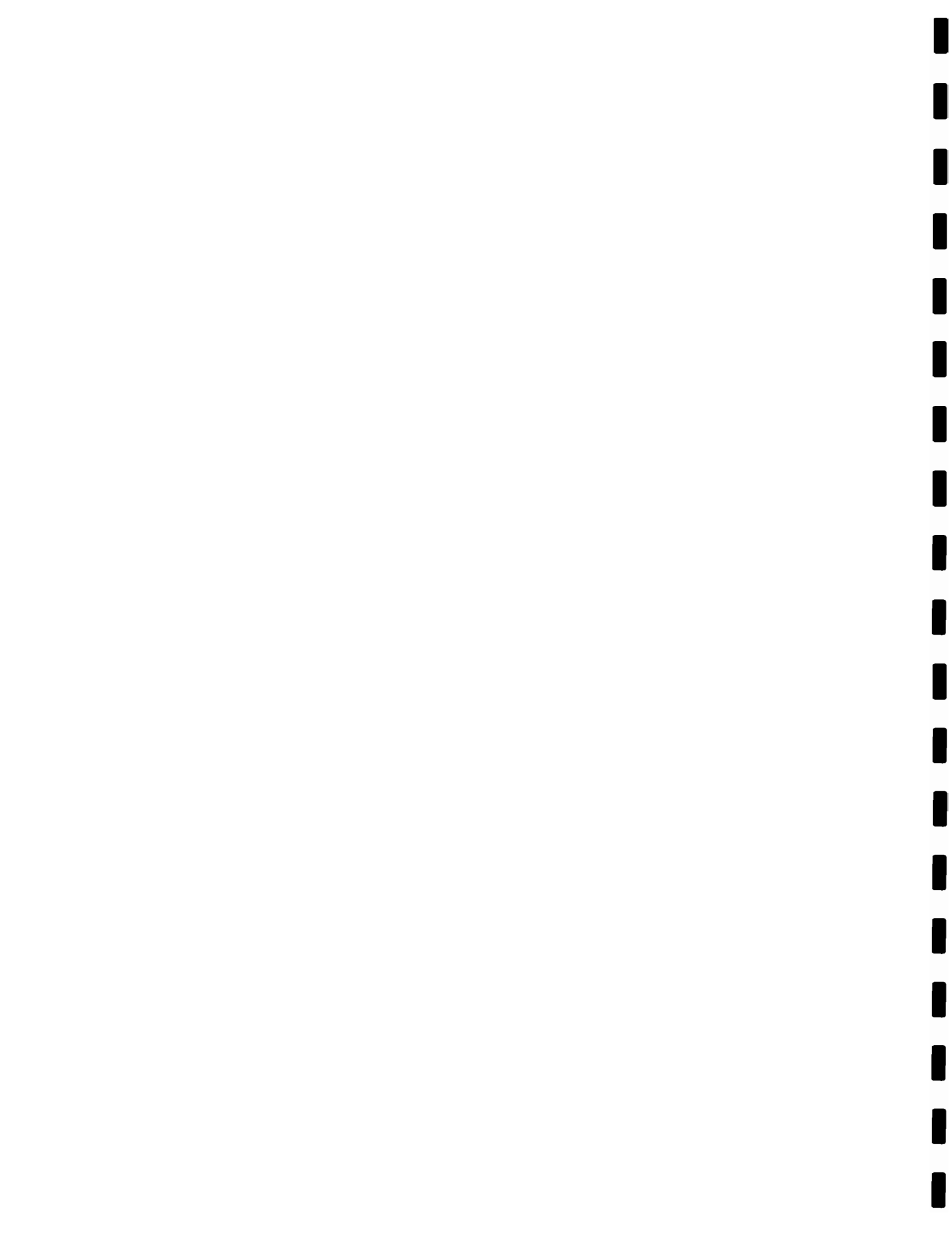
- 1) *NGK Metals Corporation, RCRA Facility Investigation (Volumes I and II)*, Document No. 05756-5, November 15, 1990;
- 2) *NGK Metals Corporation, RCRA Facility Investigation Addendum*, Document No. 5756-8, October 25, 1991; and
- 3) *RCRA Corrective Measures Study, Three Dimensional Finite-Difference Groundwater Flow Model, NGK Metals Corporation Reading Facility*, February 21, 1992.

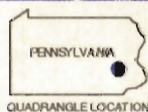
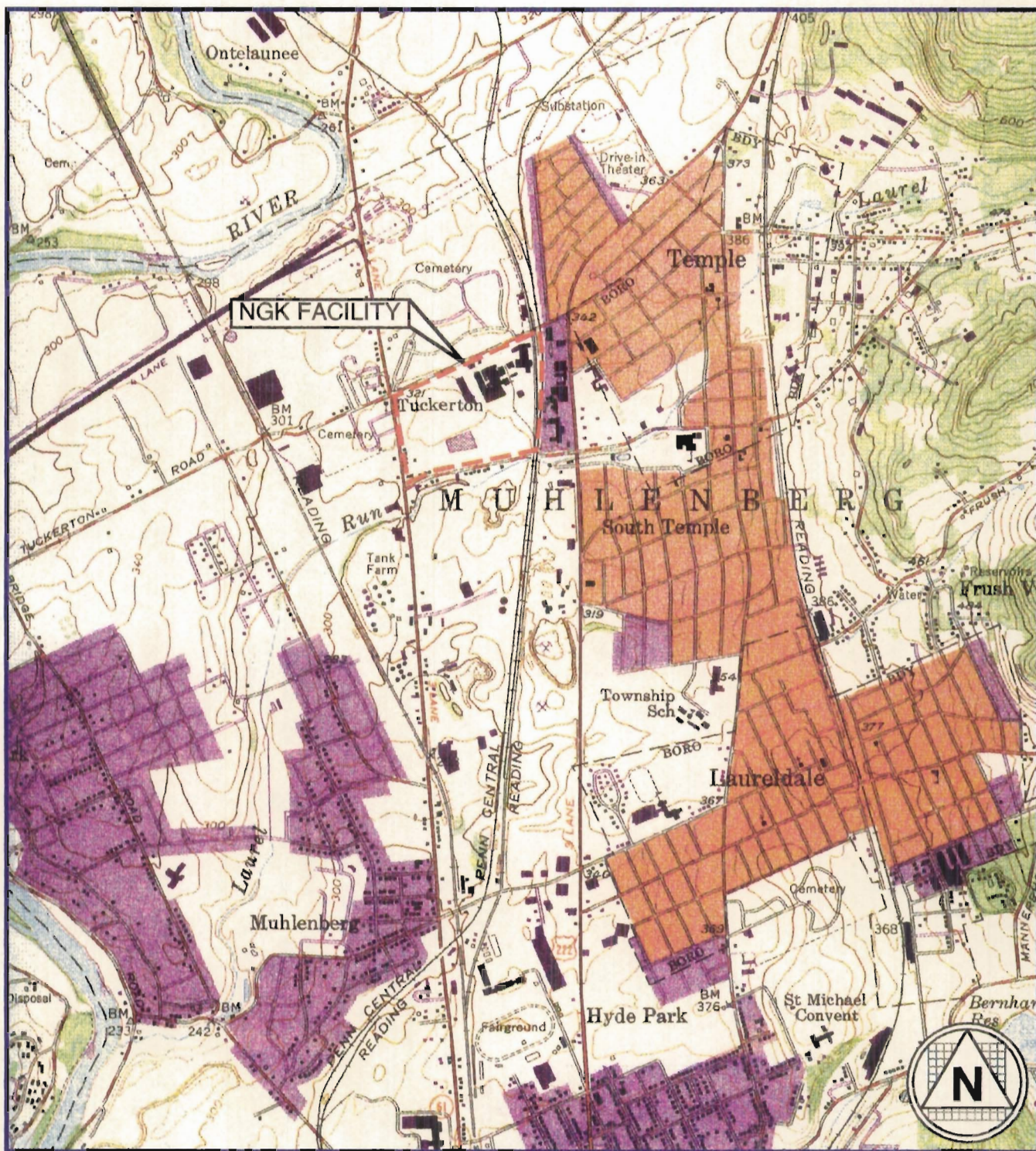
The general information presented in this section of this Pump Test Report has been discussed in greater detail in these and other reports previously generated. The information presented herein serves only as a cursory review of material compiled from these reports, and compliments data acquired during the period from June 1993 to the present. More complete descriptions of the material contained within this section can be found in the reports listed above. Specific information is presented in this report as necessary.

2.1 GEOLOGY

The NGK site, shown on Figures 2-1 and 2-2 consists of two types of unconsolidated material overlying bedrock. One type is a variable thickness, heterogeneous mixture of clay, sand, gravel and boulders. This overburden type is prevalent in the southern half of the site, and varies in thickness from approximately 20 feet to more than 60 feet. The second type of overburden is an orangish-brown residual clay, which formed from the weathering of the parent bedrock below. This clayey overburden is more commonly associated with the northern half of the site, and ranges from about 3 feet to more than 50 feet in thickness.

Typical bedrock is interbedded gray limestone and dolomite (occasionally referred to as dolostone) with occasional sandy and shaly zones, particularly near the northeastern portion of the site. The carbonate rock (i.e. limestone or dolomite) is almost always moderately to severely weathered and broken at the overburden/bedrock interface. Voids, and fractured or broken zones, are commonly encountered within the bedrock formation, and generally decrease in frequency with depth. Many of these voids and fractured zones are clay-filled and/or water-bearing zones. Top of bedrock information has been presented previously in other reports. The acquisition of additional top of bedrock data generated during the installation of the seven new monitor wells resulted in a revised bedrock elevation map, which is presented as Figure 2-3. These elevations are based on the first occurrence of weathered bedrock, generally limestone or dolomite, and were determined by field observations during well drilling and by interpretation of driller logs from pre-existing wells.





NOTE: Map Derived From U.S.G.S. 7.5 Minute
Topo. Quad. Temple, Pennsylvania
PHOTOREVISED 1968

RUST ENVIRONMENT &
INFRASTRUCTURE

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Mechanicsburg, PA 17055
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Site Location Map
RCRA Corrective Measures Implementation
NGK METALS CORPORATION
Berks Co. Reading, PA

PROJECT NO.: 35525

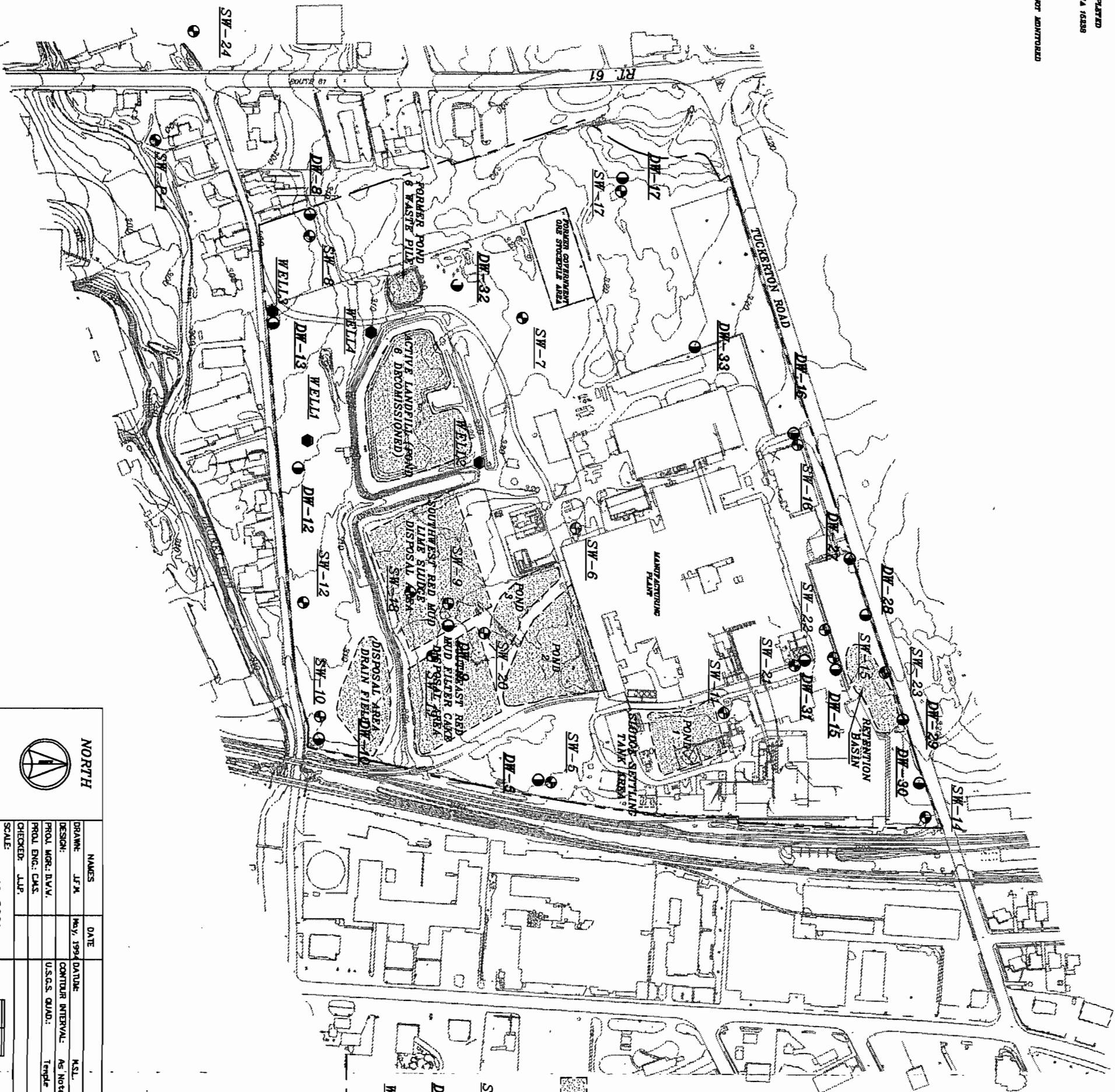
DATE: 5/94

SCALE: 1"=2000'

FIGURE NO.: 2-1

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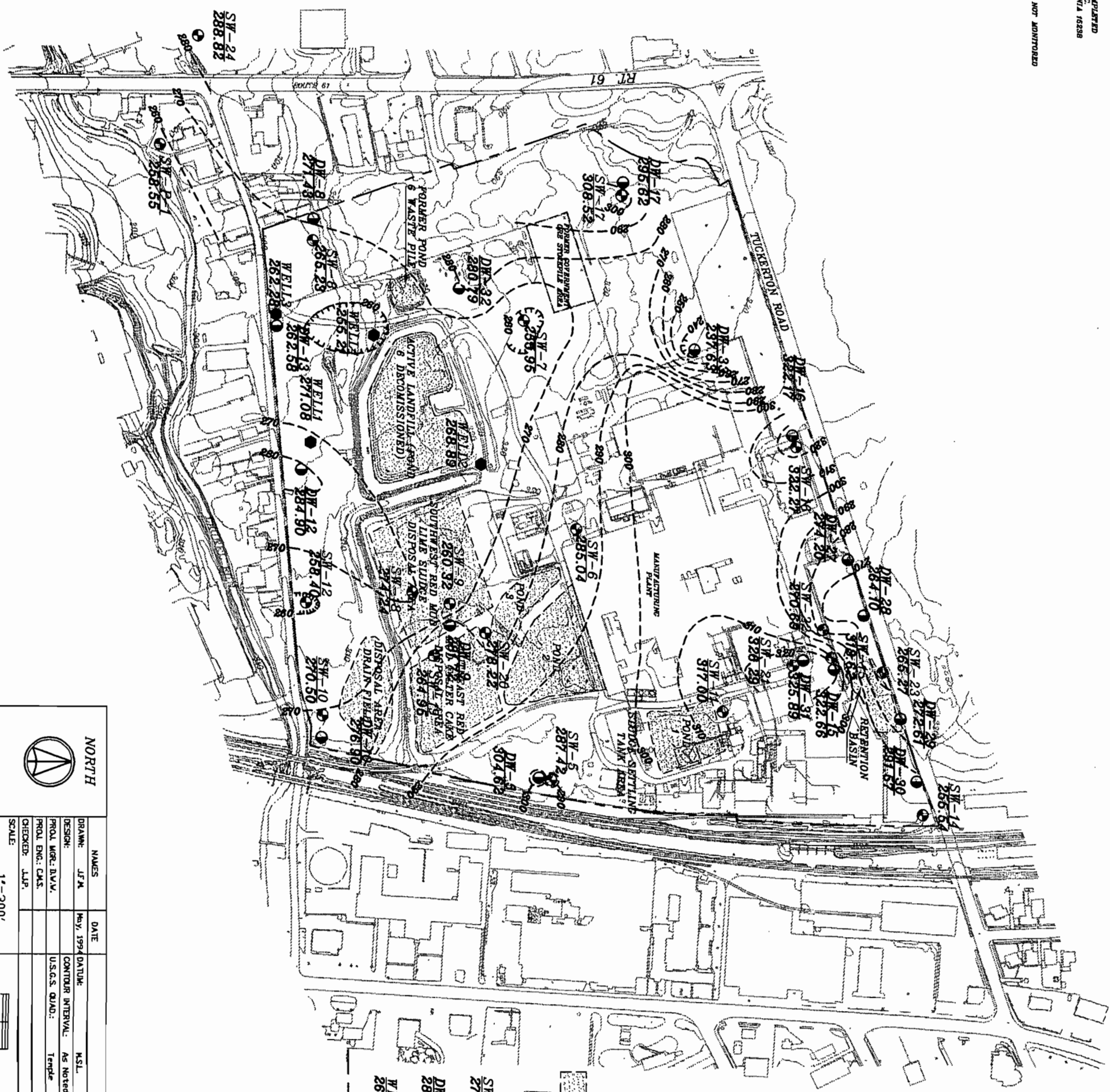
NOTES:
BASE MAP MATERIAL WAS COMPILED AND CORRECTED
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260 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15239
CONTINUATION OF SHEET 15239
TOPOGRAPHIC CONTOUR INTERVAL = 5'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



- LEGEND**
- SOLID WASTE MANAGEMENT UNIT
 - SITE FEATURES
 - SHALLOW MONITOR WELL
 - DEEP MONITOR WELL
 - LANDFILL WELL
 - PROPERTY LINE

NORTH		DRAWN: JFM		DATE: MAY 1994	DATE: 04/10/94	SCALE: 1"=300'
DESIGN: JFM		PROJ. MGR: D.V.V.		U.S.G.S. QUAD: N.S.L.		CLIENT: RUST ENVIRONMENT & INFRASTRUCTURE 2 Market Plaza, Suite 200 Pittsburgh, PA 15222 (412) 782-8000 FAX (412) 782-8000
PROJ. ENG: C.M.S.		CHECKER: JLP		TEMPLE		
SCALE: 1"=300'		PROJECT NUMBER: 35523-300		DATE: 04/10/94		
REVISION: SHEET NUMBER		PROJECT NUMBER: 35523-300		DATE: 04/10/94		
CAD FILE NAME: BASCMAP		SHEET NUMBER		PROJECT NUMBER: 35523-300		FIGURE 2-2
PLOT DATE:		SHEET NUMBER		PROJECT NUMBER: 35523-300		NGK METALS CORPORATION
		SHEET NUMBER		PROJECT NUMBER: 35523-300		SITE MAP
		SHEET NUMBER		PROJECT NUMBER: 35523-300		AR360285

NOTES:
MAP MATERIAL WAS OBTAINED AND COMPILED
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BEDROCK CONTOUR INTERVAL - 10'
TOPOGRAPHIC CONTOUR INTERVAL - 5'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED





Lithologic data acquired from new wells in the northern section of the site are consistent with previous data, and this area of the site bedrock map remains relatively unchanged. Along the western property boundary, however, new data from wells DW-32 and DW-33 results in a significant modification to the bedrock map. The data indicate that while bedrock was encountered in new well DW-32 at 36 feet, competent bedrock in DW-33 was not achieved until 116 feet. Boulders and clay were encountered between 82 and 84 feet, and broken and severely weathered rock was encountered between 98 feet and 116 feet. These intermittent boulders and thick clay horizons are characteristic of sink hole zones.

The deep soil overburden horizon along with the severely weathered bedrock may be associated with the Tuckerton fault, which appears in previous site geologic maps. The approximate location of this fault traverses across Tuckerton Road in proximity (within approximately 400 feet) to the location of well DW-33. Published reports indicate that bedrock strikes approximately N65°E and dips roughly 42°S near the site. A measurement of N42°E/32°S was made in a bedrock pinnacle in the northwest corner of the site just east of well SW-17.

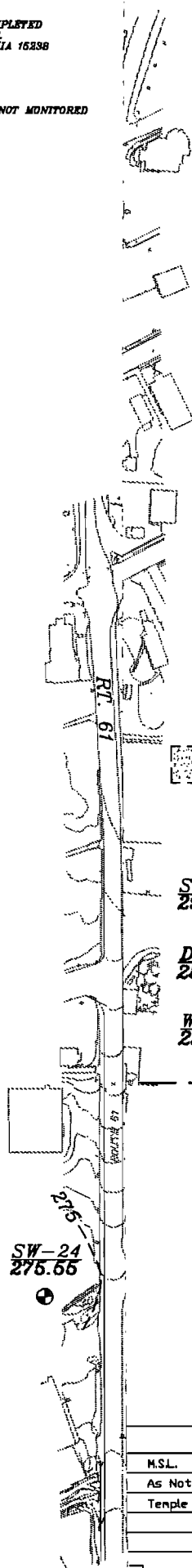
2.2 HYDROGEOLOGY/AQUIFER CHARACTERISTICS

Recent water level data (June 1993 and April 1994)) from existing on-site shallow and deep monitor wells are generally consistent with previous information, and continue to reflect slight differences in the shallow (i.e. <100 feet) and deep (i.e. >100 feet) aquifer zones. Groundwater elevations were calculated from these water levels and used to produce the contour maps presented as Figures 2-4 and 2-5, respectively. A slight elevation difference between the two zones is obvious, thus indicating an apparent (hydraulically) downward flow component from the upper aquifer zone towards the lower aquifer zone (recharge zone).

Newly acquired water level data confirm the groundwater flow patterns across the site that were established in earlier reports. Specifically, a groundwater divide essentially bisects the NGK site and trends roughly east to west. Groundwater flow within the shallow aquifer zone closely mimics the local topography. Generally, the groundwater elevation contours are more irregular (see Figures 2-4 and 2-5). The deeper aquifer zone typically reflects regional groundwater flow trends with the groundwater elevation contours generally more regular and consistent. Local flow in the southern portion of the site is generally towards Laurel Run. Regional groundwater flow is towards the Schuylkill River which, is generally to the west of the site. The Schuylkill River is closest to the site approximately one-half mile to the northwest.

Previous reports have included discussions on three vertical zones within the water table aquifer proximal to and beneath the NGK site. These are the Unconsolidated Soil (soil) Zone, the Unconsolidated Soil/Bedrock Interface (interface and upper portion of broken weathered bedrock) Zone, and the Bedrock (deeper more competent bedrock) Zone. Prior aquifer test (i.e. slug tests) data indicate that the interface zone is generally the most hydraulically conductive of the three zones. Mean hydraulic conductivity estimates from available data are 8.0×10^{-1} ft/day, 3.3×10^1 ft/day, and 4.9×10^0 ft/day, respectively.

NOTES:
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 TOPOGRAPHIC CONTOUR INTERVAL = 2'
 WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



LEGEND

SOLID WASTE MANAGEMENT UNIT

SITE FEATURES

SW-10
294.32

SHALLOW MONITOR WELL
BEDROCK ELEVATION

DW-12
285.76

DEEP MONITOR WELL
BEDROCK ELEVATION

WELL2
297.40

LANDFILL WELL
BEDROCK ELEVATION

PROPERTY LINE

SW-24
275.55

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M.S.L.
As Noted
Temple

CLIENT
DWG. NO.
RUST
DWG. NO.
PROJECT NUMBER 35923.300
DATE
REVISION
NUMBER

SHEET NUMBER
OF

FIGURE 2-4
GROUNDWATER ELEVATION MAP

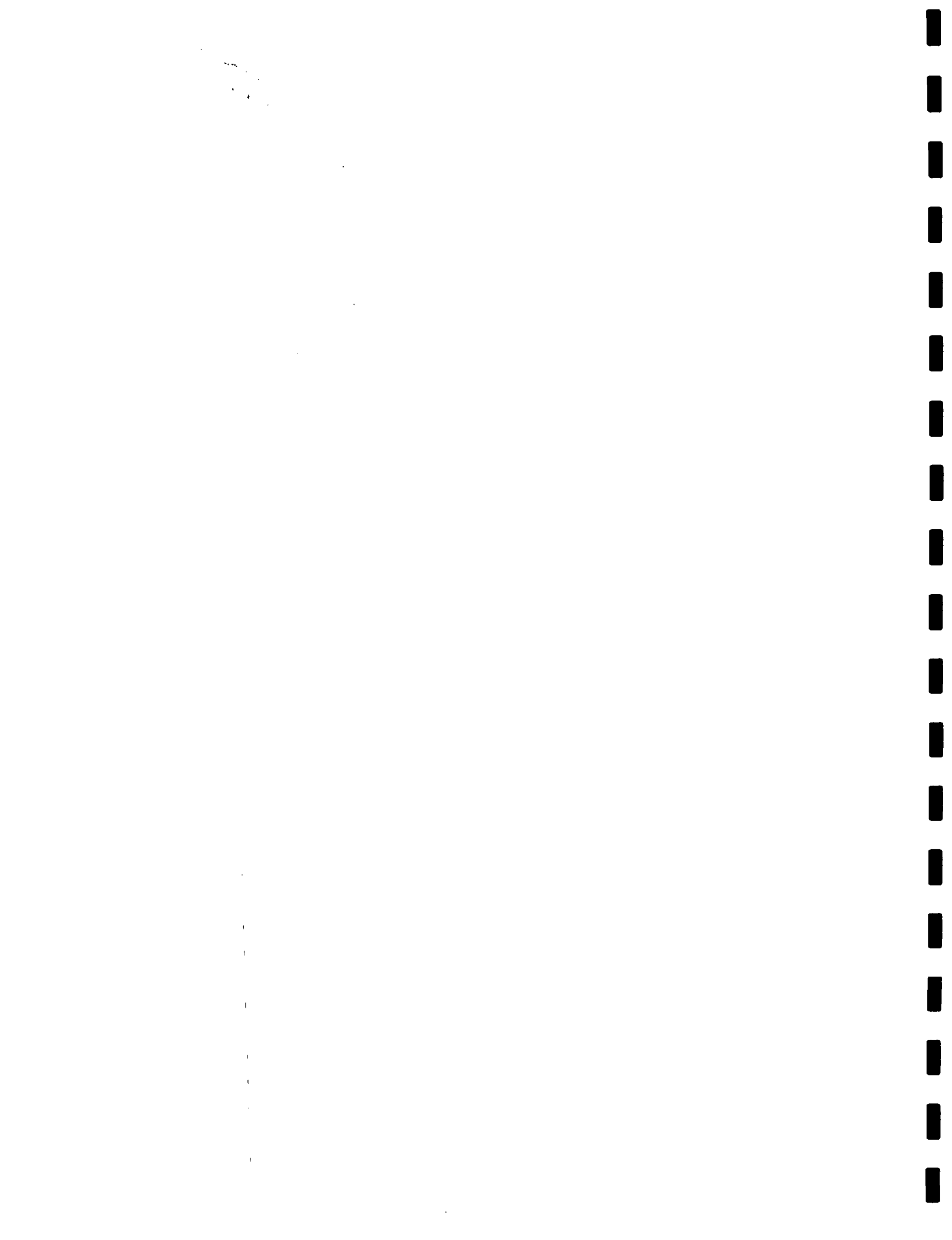
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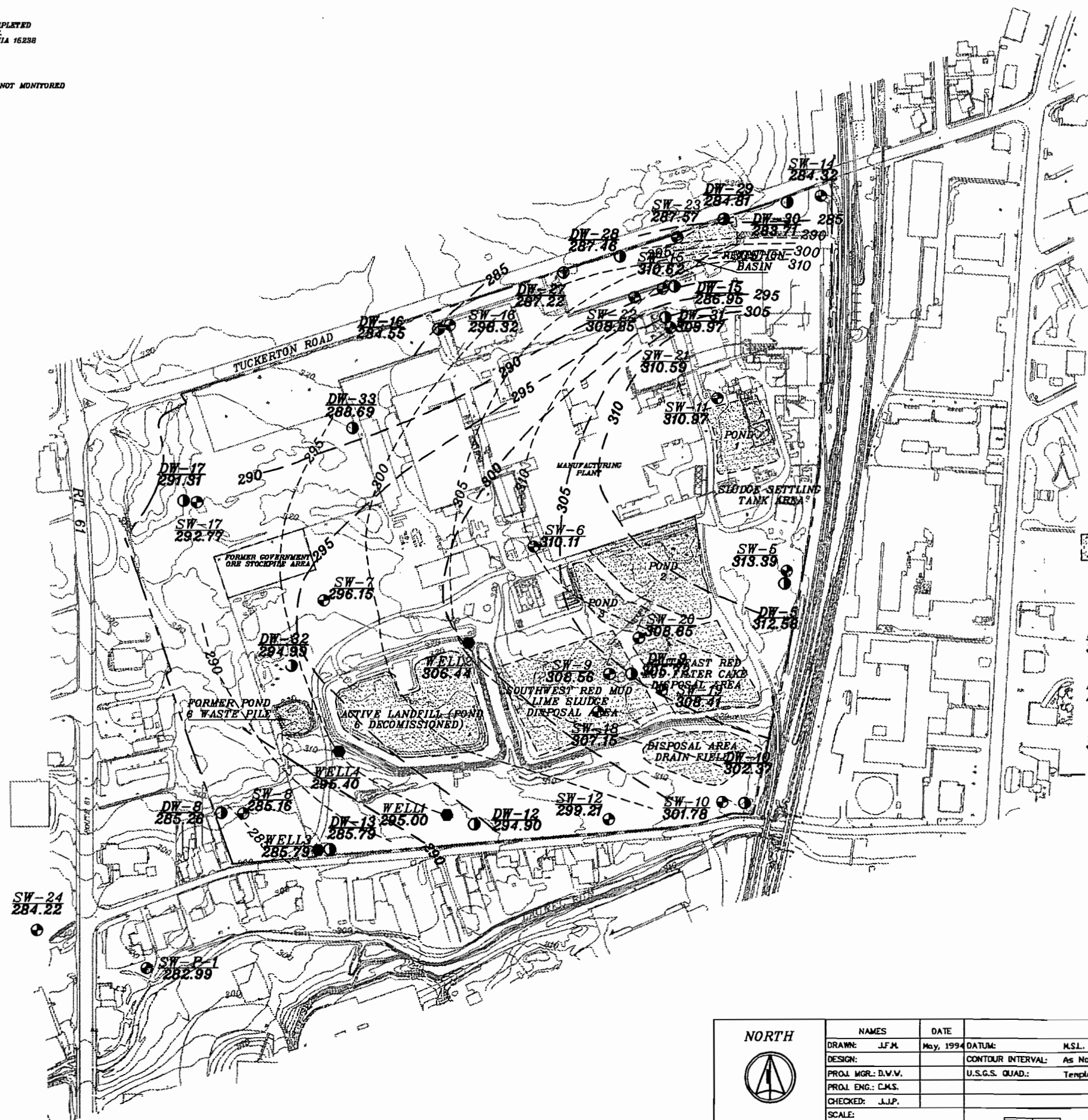
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- LEGEND**
- SOLID WASTE MANAGEMENT UNIT
 - SITE FEATURES
 - SHALLOW MONITOR WELL
GROUNDWATER ELEVATION
 - DEEP MONITOR WELL
GROUNDWATER ELEVATION
 - LANDFILL WELL
GROUNDWATER ELEVATION
 - PROPERTY LINE

NORTH

NAMES	DATE	DATUM	MSL.
DRAWN: J.F.M.	May, 1994		
DESIGN:		CONTOUR INTERVAL:	As Noted
PROJ. MGR.: D.V.V.		U.S.G.S. QUAD.:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:	1"=300'		

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 Mechanicsburg, PA 17055
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FIGURE 2-5
 GROUNDWATER ELEVATION MAP
 APRIL 5, 1994

ANK METALS CORPORATION
 Berks County, Pennsylvania

CAD FILE NAME: CONTFULLSITE4-5-94
 PLOT DATE:



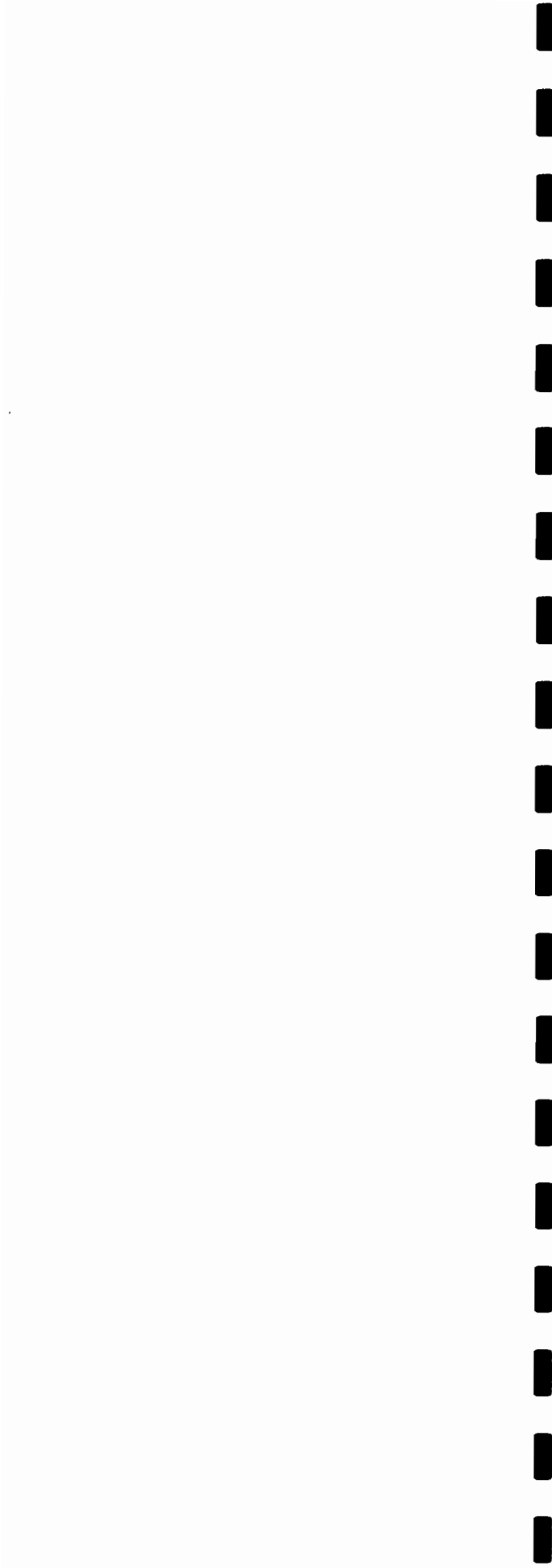
Five of the seven new wells (DW-27 through DW-30 and DW-33) were constructed such that the screened interval spanned the overburden/bedrock interface zone. Shallow on-site wells are generally constructed across this interface. Despite this similarity, however, the water levels in the new wells are more consistent with those in the deep wells. This is likely due to the screened interval being within a larger portion of the bulk aquifer compared to any shallow well. New wells DW-31 DW-32 are constructed differently. Here, the screened intervals are totally within the bedrock zone.

2.3 GROUNDWATER WELL NETWORK

Initially, a total of thirty-one (31) monitor wells were installed as part of the NGK RFI study. Four (4) other monitor wells had existed prior to these wells as required by conditions established in the Industrial Landfill permit. Since the last report, the well labeling system has been revised. In previous reports shallow wells were labeled with an "A" (e.g. MW-5A) and deep wells carried a "B" label (e.g. MW-5B). This labeling system has been changed to eliminate any previous confusion as to which well is constructed within the shallow aquifer or deep aquifer. For this report and future reference, shallow wells are labeled "SW" and deep wells are "DW." A well correlation summary is presented in Table 2-1

TABLE 2-1
WELL CORRELATION SUMMARY

SHALLOW WELLS:		DEEP WELLS:	
<u>Old Designation</u>	<u>New Designation</u>	<u>Old Designation</u>	<u>New Designation</u>
MW-5A	SW-5	MW-5B	DW-5
MW-6A	SW-6	MW-8B	DW-8
MW-7A	SW-7	MW-9B	DW-9
MW-8A	SW-8	MW-10B	DW-10
MW-9A	SW-9	MW-12B	DW-12
MW-10A	SW-10	MW-13B	DW-13
MW-11A	SW-11	MW-15B	DW-15
MW-12A	SW-12	MW-16B	DW-16
MW-14A	SW-14	MW-17B	DW-17
MW-15A	SW-15	MW-25B	DW-25
MW-16A	SW-16	MW-26B	DW-26
MW-17A	SW-17	-	DW-27
MW-18A	SW-18	-	DW-28
MW-19A	SW-19	-	DW-29
MW-20A	SW-20	-	DW-30
MW-21A	SW-21	-	DW-31
MW-23A	SW-23	-	DW-32
MW-24A	SW-24	-	DW-33
P-1	SW-P-1		
Well 1	unchanged		
Well 2	unchanged		
Well 3	unchanged		
Well 4	unchanged		



Between June 1993 and March 1994, seven (7) new potential groundwater recovery wells, henceforth identified as DW-27, 28, 29, 30, 31, 32 and 33, were drilled and constructed primarily in two areas of the site based on the following information determined by previous site investigations:

- identified contaminant source areas;
- known groundwater flow direction(s);
- confirmed groundwater chemistry characteristics;
- aquifer characteristics determined by limited pump test results of existing wells SW-9, 19 and 15; and
- evaluation of the hydraulic behavior of aquifer materials proximal to and beneath the site through the use of a groundwater flow model.

Wells DW-27 through 30 span the northern property boundary along Tuckerton Road. Well DW-31 is located inside the plant area also in the northern portion of the site. Wells DW-32 and 33 are found along the west-central property boundary, which approaches PA Route 61 (Pottsville Pike). The rationale for the location of these new wells is generally associated with existing data gaps (e.g., aquifer characteristics, groundwater flow direction, groundwater chemistry) in specific areas of known contamination, and the lack of wells exhibiting sufficient yield in these same areas that could potentially be used for groundwater withdrawal. Previous investigations have determined that the pre-existing, as constructed wells located in the northern half of the site generally do not exhibit as high a yield as those wells constructed in the southern part of the site. Additionally, analytical data from the pre-existing monitor wells near the northern perimeter of the site indicate that groundwater has been adversely impacted by previous industrial activities.

Groundwater from wells located in the southern half of the site has also been impacted. However, a sufficient number of wells exist that produce adequate yields to be considered for use as effective groundwater withdrawal wells. Therefore, the principal area of new well installations was along the northern perimeter of the site. Additionally there appeared to be data gaps between monitor wells SW-7 and Well 4, and SW-7 and well set 16. Thus, new wells DW-32 and DW-33 were also established.

Five (5) of the new wells (DW-27 through DW-31) are located in proximity to an identified contaminant source, specifically, the former Retention Pond. A previously conducted seven (7) gallon per minute (gpm) pump test at monitor well SW-15 resulted in a maximum radius of influence of approximately 100 to 150 feet. Therefore, the anticipated area of influence created by pumping SW-15 alone was considered insufficient to effectively capture and contain contaminated groundwater in this area and to prevent off-site migration. The rationale for the



additional new wells was based on the results of the SW-15 pump test and the need for potential groundwater recovery wells near a known source of groundwater contamination.

It was anticipated that the installation of the five new deeper wells would increase the likelihood of encountering higher yielding (i.e. >5 gpm) water bearing zones that exhibit hydraulic connection to the bulk aquifer system. In this way, effective hydraulic containment possibly could be achieved using fewer wells with larger effective areas of capture rather than more wells with smaller areas of capture.

New monitor wells DW-27 and 28 were installed between existing wells SW-16 and SW-23. The location of the new wells was also based on the pump test results on well SW-15, which, as stated above, indicated a radius of influence of approximately 100-150 feet. Therefore, it was essential that two additional wells be located in a manner that, if selected for use as recovery wells, would prevent migration of contamination from the Retention Pond area along the northern border of the site. The estimated yields of wells DW-27 and 28 are greater than 90 gpm and approximately 5 gpm, respectively.

New wells DW-29 and DW-30 were installed in the northeast corner of the site between existing wells SW-23 and SW-14. As mentioned above, pump testing of well SW-15 resulted in a radius of influence of approximately 100-150 feet. Therefore, wells DW-29 and DW-30 were spaced as close to this distance as practical. In this area of known groundwater contamination, neither of the two existing wells (SW-23 and SW-14) currently yield more than an estimated 5 gpm. According to published reports, the Leithsville Formation exists near the northwest corner of the site. Monitor well SW-14 is believed to be within this geologic formation, which is reportedly, conducive to high yielding wells. Although SW-14 is a moderate yielding well (approximately 3 gpm), DW-25, which is a deeper well (178 feet deep) and is located just north of the Blue Mountain Railroad Station, produces approximately 15 gpm. Based on this characteristic of the underlying bedrock, it was anticipated that the likelihood of one, if not both, of the new wells encountering sufficient (i.e. >5 gpm) yield was favorable. The objective of installing DW-29 and DW-30 was to install two new wells that would potentially yield more than any existing well in this area of the site. Estimated well yields of DW-29 and DW-30 are approximately 70 gpm and less than 2 gpm, respectively.

Deep well (i.e. greater than 100 feet) DW-31 was installed next to existing well SW-21. During the drilling and installation of monitor well SW-21, a void was encountered that caused a loss of drill hole materials (i.e. rock chips and water). The well was completed to 60 feet total depth. As a result of lost circulation, not much is known about the water yielding capabilities of this well. Well DW-31 was installed with the intent of encountering water-bearing zones with greater yield than any of the existing wells in this immediate area. The estimated yield of this well is less than 2 gpm.

Two deep wells, DW-32 and DW-33 were installed along the western property boundary in areas with insufficient data characterizing groundwater flow and quality. Well DW-32 was installed approximately mid-way between shallow wells SW-7 and (landfill) Well 4. The estimated well yield is 10 gpm. DW-33 was initially installed between well SW-7 and well set 16 within the



storage area along the fence near the northwestern corner of the site. This well was drilled to 150 feet and was essentially dry. The re-drilled well is located just outside the fence near the southeast corner of the employee parking lot. The well was developed and sampled at a 10 gpm rate during which the water level was only slightly effected. Well logs for the new and pre-existing wells are presented in Appendix A. Table 2-2 summarizes monitor well data including information from the new wells.

The installation, development and testing of new wells provides additional data collection points that supplement existing site characterization information. The seven (7) new wells are integrated into the existing well network, which is comprised of four (4) landfill (shallow) wells, twenty (20) shallow monitor wells (including off-site piezometer P-1) and seventeen (17) deep wells that are located on or adjacent to the site (shallow well SW-24, piezometer P-1 and deep well DW-25 are located within several hundred feet of the site). This network of wells was evaluated to select individual wells anticipated to be optimal for groundwater recovery in terms of sustainable pumping rates and the most effective capture of contaminated groundwater. Pump tests have been performed on select wells both in the northern and southern portions of the site. These data have been analyzed and are presented in the following section of this report.

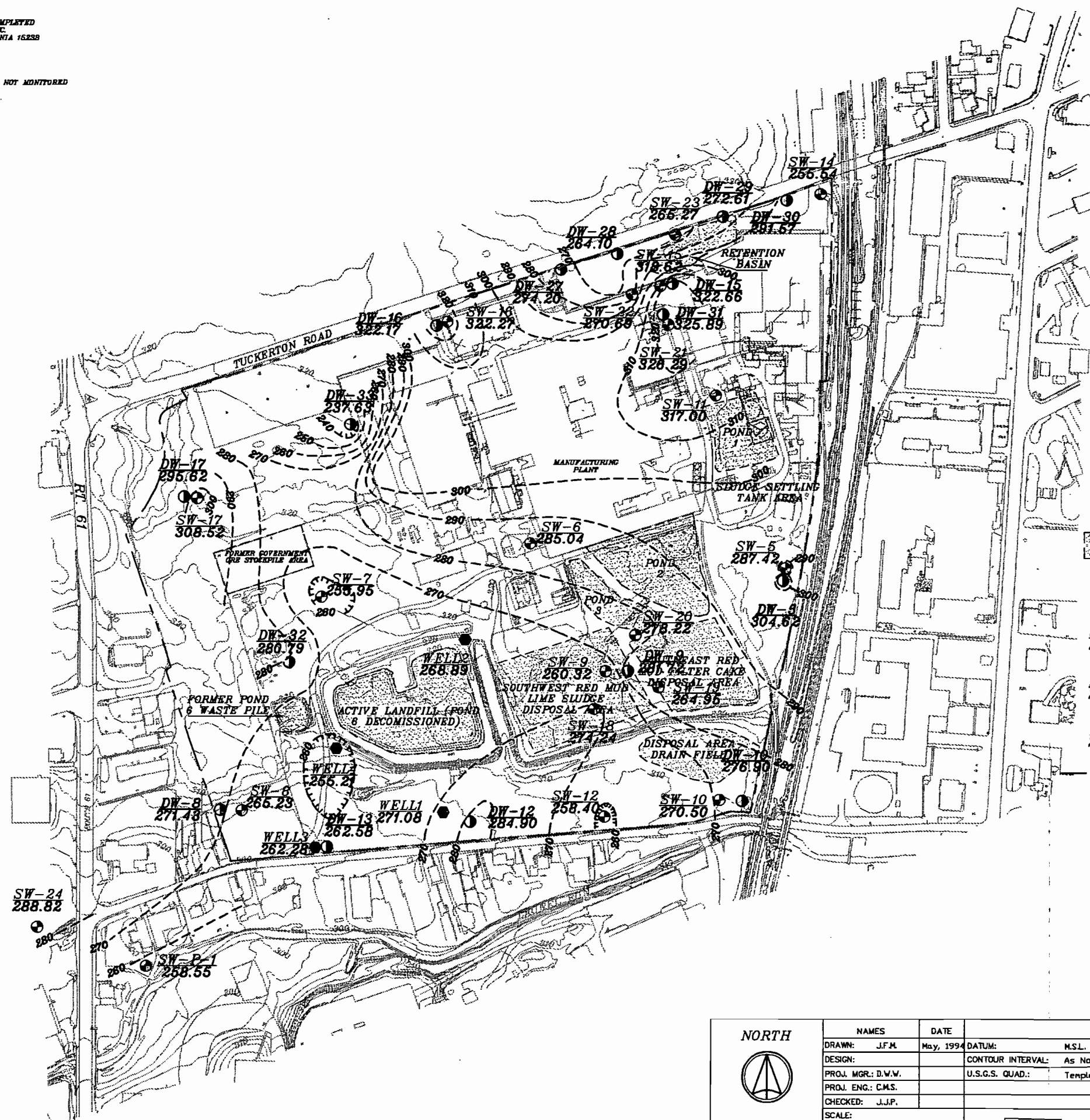


TABLE 2-2
MONITOR WELL DATA SUMMARY

WELL	SURFACE ELEV. (ft. above MSL)	TOC ELEV. (ft. above MSL)	DEPTH TO BEDROCK (feet)	BEDROCK ELEV. (ft. above MSL)	TOTAL DEPTH (feet)	SCREEN INTERVAL (feet)	WELL TYPE	ESTIMATED YIELD (gpm)
Well 1	306.08	308.08	35	271.08	50	24-50	8" slotted steel casing	30
Well 2	320.89	322.11	52	268.89	53	40-53	8" slotted steel casing	3
Well 3	302.28	304.24	40	262.28	55	30-55	8" slotted steel casing	15
Well 4	310.21	311.73	55	255.21	75	12-75	8" slotted steel casing	1
SW-5	327.42	329.56	40	287.42	48	28-48	4" PVC	>10
DW-5	327.62	329.62	23	304.62	175	100-175	6" open rock	2
SW-6	326.04	327.99	41	285.04	51	31-51	4" PVC	>5
SW-7	318.95	320.71	63	255.95	75	48-68	4" PVC	3
SW-8	303.23	304.71	38	265.23	61	37-57	4" PVC	25
DW-8	303.43	304.58	32	271.43	151	110-151	6" open rock	4
SW-9	Not measured	333.22	55	260.32	75	62-75	6" open rock	60
DW-9	Not measured	333.63	52	281.72	200	125-200	6" open rock	2
SW-10	311.5	312.8	41	270.50	41	21-41	4" PVC	3
DW-10	311.9	313.15	35	276.90	123	94-123	6" open rock	10
SW-11	328	330	11	317.00	73	20-73	6" open rock	3
SW-12	309.4	311.6	51	258.40	60	35-55	4" PVC	5
DW-12	305.9	307.83	21	284.90	160	100-160	6" open rock	150
DW-13	302.58	304.45	40	262.58	165	105-165	6" open rock	150
SW-14	326.54	327.97	71	255.54	76	48-68	4" PVC	3
SW-15	327.62	329.56	9	318.62	68	46.5-66.5	4" PVC	5
DW-15	327.66	329.63	5	322.66	175	118-175	6" open rock	<5
SW-16	327.27	328.74	5	322.27	75	12-75	6" open rock	2
DW-16	326.17	327.54	4	322.17	200	125-200	6" open rock	2
SW-17	319.52	321.16	11	308.52	75	20-75	6" open rock	2
DW-17	317.62	319.39	22	295.62	200	125-200	6" open rock	2
SW-18	Not measured	332.33	49	274.24	55.5	35.5-55.5	6" PVC	15-25
SW-19	Not measured	334.11	60	264.95	65	35-65	6" PVC	50
SW-20	Not measured	334.56	47	278.22	52	32-52	6" PVC	30
SW-21	329.79	331.99	3.5	326.29	60	25-60	2" PVC	NA
SW-22	328.19	330.39	57.5	270.69	72	32-72	4" PVC	4
SW-23	327.27	327.27	62	265.27	73	43-73	4" PVC	5
SW-24	298.82	298.82	10	288.82	63	33-63	4" PVC	5
DW-25	325.46	327.26	37	288.46	178	72-178	6" open rock	10
DW-26	283.28	284.48	39	244.28	202	42-202	6" open rock	3
DW-27	328.2	328.2	54	274.20	118	68-118	4" PVC	100
DW-28	327.1	327.1	63	264.10	120	70-120	4" PVC	4-5
DW-29	325.61	325.61	53	272.61	120	60-120	6" PVC	75
DW-30	325.57	326.51	34	291.57	121	60-120	4" PVC	2-4
DW-31	328.89	331.3	3	325.89	153	16-153	6" open rock	1
DW-32	316.79	319.49	36	280.79	157	59-150	6" open rock	10
DW-33	319.63	321.33	82	237.63	127	67-120	4" PVC	10
SW-P-1	300.55	302.35	>42	<258.55	45	35-40	2" PVC	15



NOTES:
 BASE MAP MATERIAL WAS COMPILED AND COMPLETED
 BY AERIAL DATA REDUCTION ASSOCIATES, INC.
 220 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15228
 BEDROCK CONTOUR INTERVAL - 10'
 TOPOGRAPHIC CONTOUR INTERVAL - 2'
 WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



LEGEND

- SOLID WASTE MANAGEMENT UNIT
- SITE FEATURES
- SHALLOW MONITOR WELL
BEDROCK ELEVATION
- DEEP MONITOR WELL
BEDROCK ELEVATION
- LANDFILL WELL
BEDROCK ELEVATION
- PROPERTY LINE

NORTH



NAMES	DATE	DATUM	M.S.L.
DRAWN: J.F.M.	May, 1994	CONTOUR INTERVAL:	As Noted
DESIGN:		U.S.G.S. QUAD:	Temple
PROJ. MGR.: D.W.W.			
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:	1"=300'		

RUST ENVIRONMENT & INFRASTRUCTURE

2 Market Plaza Way
 Mechanicsburg, PA 17055
 (717) 765-8001
 (717) 765-8220 Fax

CLIENT DWS. NO.	
RUST DWS. NO.	
PROJECT NUMBER	35525.300
DATE	
REVISION NUMBER	0
SHEET NUMBER	OF

FIGURE 2-3
 BEDROCK ELEVATION MAP
 NGK METALS CORPORATION

AR360286

Pennsylvania

CAD FILE NAME: CONTBED
 PLOT DATE:

Between June 1993 and March 1994, seven (7) new potential groundwater recovery wells, henceforth identified as DW-27, 28, 29, 30, 31, 32 and 33, were drilled and constructed primarily in two areas of the site based on the following information determined by previous site investigations:

- identified contaminant source areas;
- known groundwater flow direction(s);
- confirmed groundwater chemistry characteristics;
- aquifer characteristics determined by limited pump test results of existing wells SW-9, 19 and 15; and
- evaluation of the hydraulic behavior of aquifer materials proximal to and beneath the site through the use of a groundwater flow model.

Wells DW-27 through 30 span the northern property boundary along Tuckerton Road. Well DW-31 is located inside the plant area also in the northern portion of the site. Wells DW-32 and 33 are found along the west-central property boundary, which approaches PA Route 61 (Pottsville Pike). The rationale for the location of these new wells is generally associated with existing data gaps (e.g., aquifer characteristics, groundwater flow direction, groundwater chemistry) in specific areas of known contamination, and the lack of wells exhibiting sufficient yield in these same areas that could potentially be used for groundwater withdrawal. Previous investigations have determined that the pre-existing, as constructed wells located in the northern half of the site generally do not exhibit as high a yield as those wells constructed in the southern part of the site. Additionally, analytical data from the pre-existing monitor wells near the northern perimeter of the site indicate that groundwater has been adversely impacted by previous industrial activities.

Groundwater from wells located in the southern half of the site has also been impacted. However, a sufficient number of wells exist that produce adequate yields to be considered for use as effective groundwater withdrawal wells. Therefore, the principal area of new well installations was along the northern perimeter of the site. Additionally there appeared to be data gaps between monitor wells SW-7 and Well 4, and SW-7 and well set 16. Thus, new wells DW-32 and DW-33 were also established.

Five (5) of the new wells (DW-27 through DW-31) are located in proximity to an identified contaminant source, specifically, the former Retention Pond. A previously conducted seven (7) gallon per minute (gpm) pump test at monitor well SW-15 resulted in a maximum radius of influence of approximately 100 to 150 feet. Therefore, the anticipated area of influence created by pumping SW-15 alone was considered insufficient to effectively capture and contain contaminated groundwater in this area and to prevent off-site migration. The rationale for the



Lithologic data acquired from new wells in the northern section of the site are consistent with previous data, and this area of the site bedrock map remains relatively unchanged. Along the western property boundary, however, new data from wells DW-32 and DW-33 results in a significant modification to the bedrock map. The data indicate that while bedrock was encountered in new well DW-32 at 36 feet, competent bedrock in DW-33 was not achieved until 116 feet. Boulders and clay were encountered between 82 and 84 feet, and broken and severely weathered rock was encountered between 98 feet and 116 feet. These intermittent boulders and thick clay horizons are characteristic of sink hole zones.

The deep soil overburden horizon along with the severely weathered bedrock may be associated with the Tuckerton fault, which appears in previous site geologic maps. The approximate location of this fault traverses across Tuckerton Road in proximity (within approximately 400 feet) to the location of well DW-33. Published reports indicate that bedrock strikes approximately N65°E and dips roughly 42°S near the site. A measurement of N42°E/32°S was made in a bedrock pinnacle in the northwest corner of the site just east of well SW-17.

2.2 HYDROGEOLOGY/AQUIFER CHARACTERISTICS

Recent water level data (June 1993 and April 1994)) from existing on-site shallow and deep monitor wells are generally consistent with previous information, and continue to reflect slight differences in the shallow (i.e. <100 feet) and deep (i.e. >100 feet) aquifer zones. Groundwater elevations were calculated from these water levels and used to produce the contour maps presented as Figures 2-4 and 2-5, respectively. A slight elevation difference between the two zones is obvious, thus indicating an apparent (hydraulically) downward flow component from the upper aquifer zone towards the lower aquifer zone (recharge zone).

Newly acquired water level data confirm the groundwater flow patterns across the site that were established in earlier reports. Specifically, a groundwater divide essentially bisects the NGK site and trends roughly east to west. Groundwater flow within the shallow aquifer zone closely mimics the local topography. Generally, the groundwater elevation contours are more irregular (see Figures 2-4 and 2-5). The deeper aquifer zone typically reflects regional groundwater flow trends with the groundwater elevation contours generally more regular and consistent. Local flow in the southern portion of the site is generally towards Laurel Run. Regional groundwater flow is towards the Schuylkill River which, is generally to the west of the site. The Schuylkill River is closest to the site approximately one-half mile to the northwest.

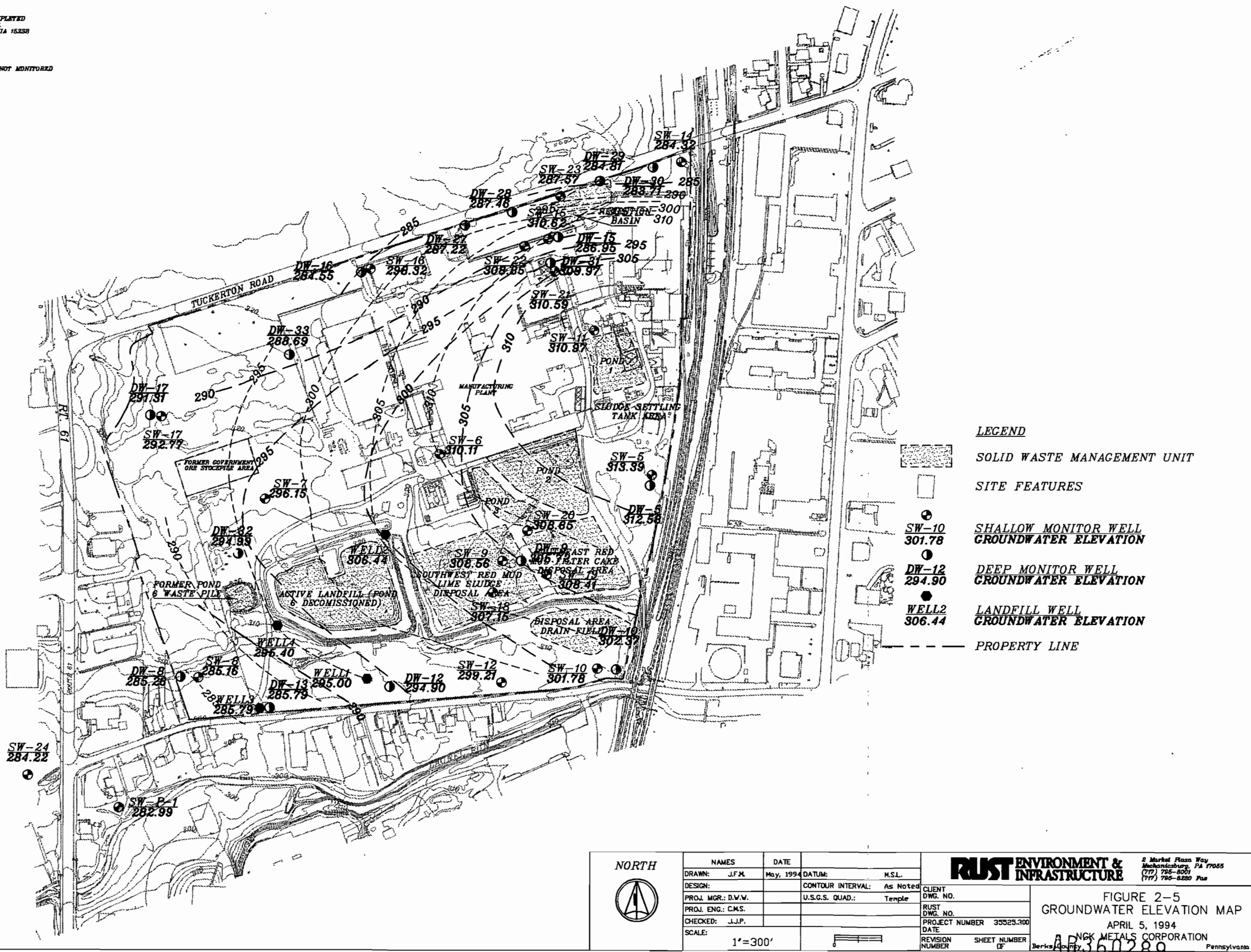
Previous reports have included discussions on three vertical zones within the water table aquifer proximal to and beneath the NGK site. These are the Unconsolidated Soil (soil) Zone, the Unconsolidated Soil/Bedrock Interface (interface and upper portion of broken weathered bedrock) Zone, and the Bedrock (deeper more competent bedrock) Zone. Prior aquifer test (i.e. slug tests) data indicate that the interface zone is generally the most hydraulically conductive of the three zones. Mean hydraulic conductivity estimates from available data are 8.0×10^{-1} ft/day, 3.3×10^1 ft/day, and 4.9×10^0 ft/day, respectively.

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
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280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238

GROUNDWATER CONTOUR INTERVAL - 5

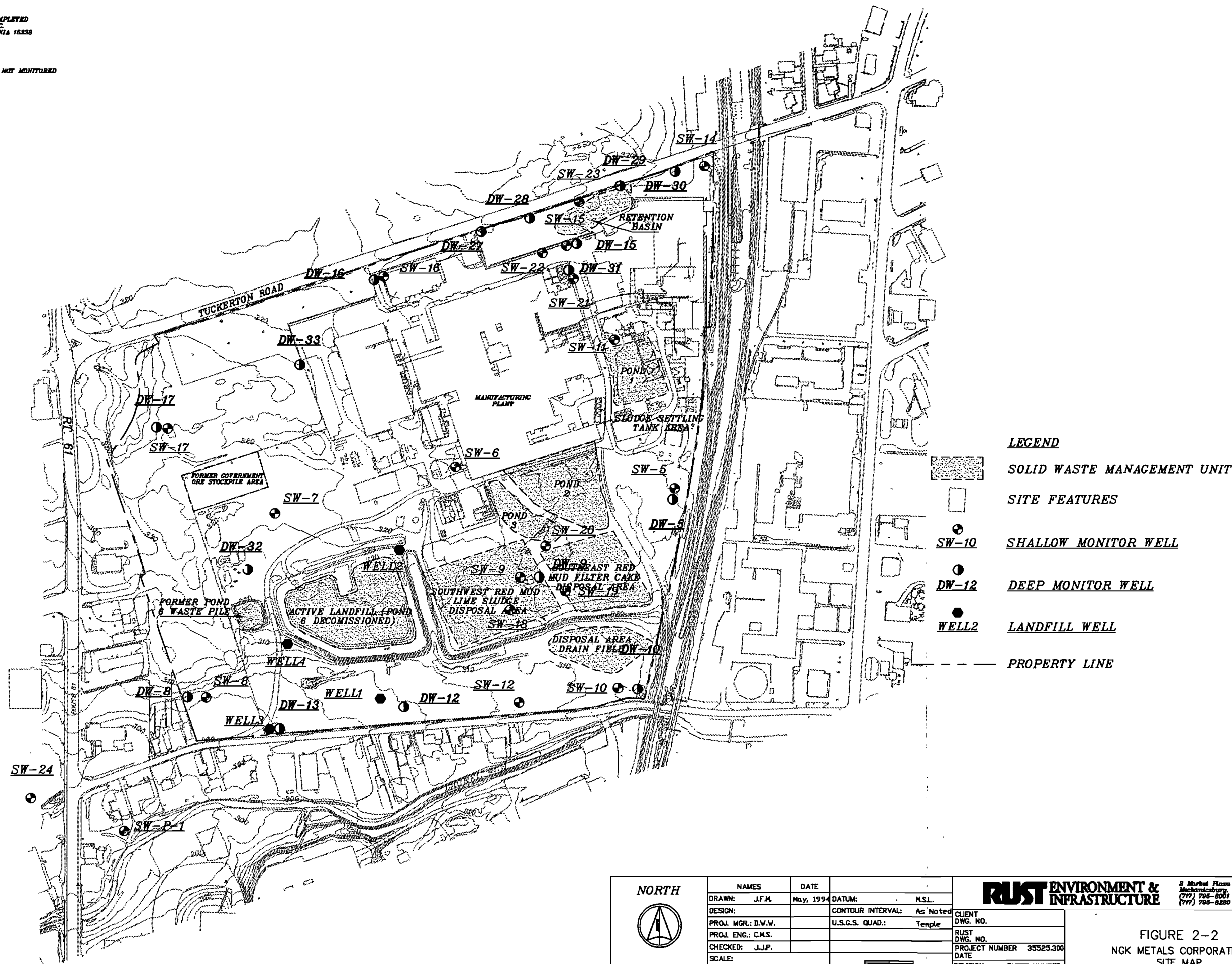
TOPOGRAPHIC CONTOUR INTERVAL = 2'

WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED

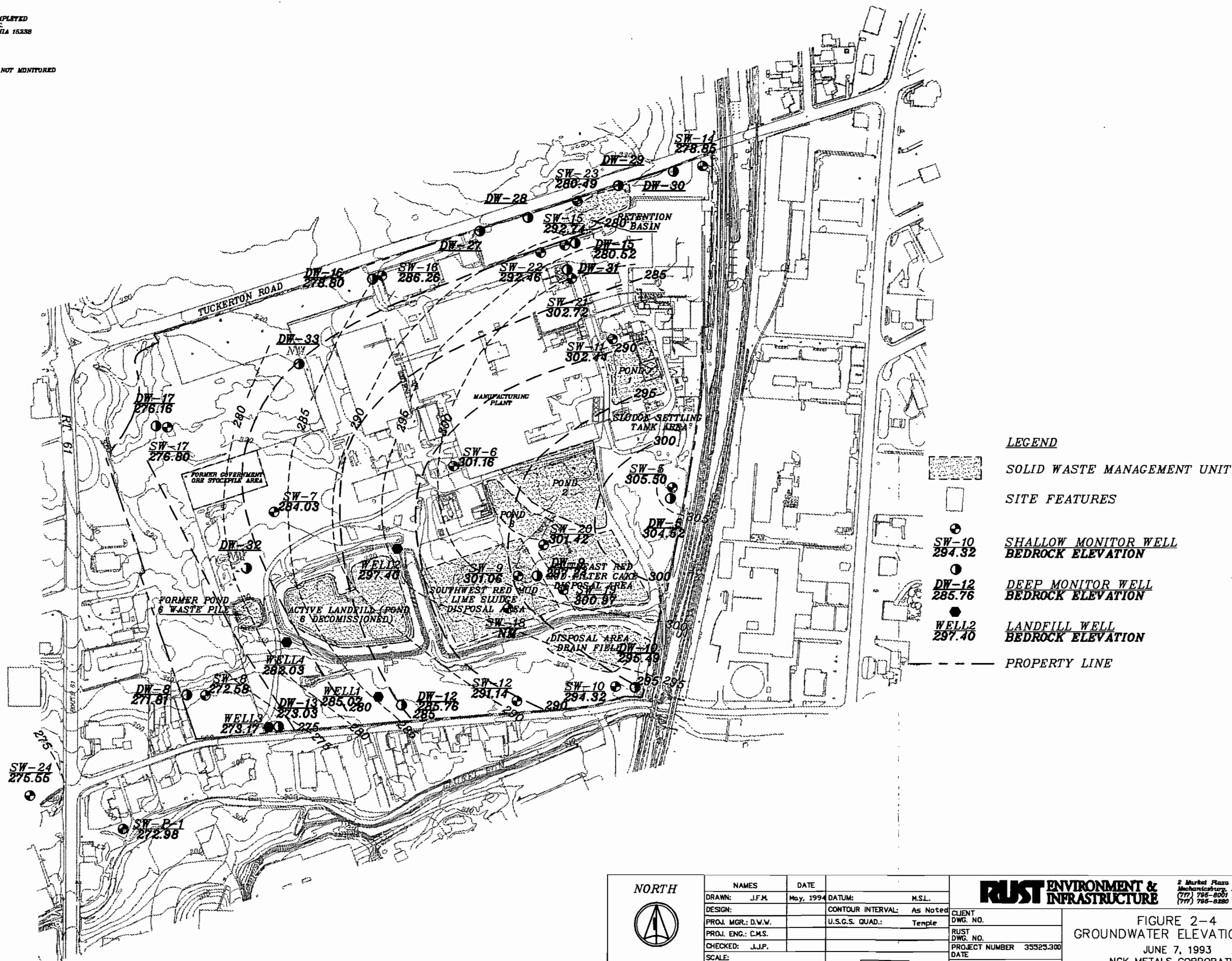




NOTES:
 BASE MAP MATERIAL WAS COMPILED AND COMPLETED
 BY AERIAL DATA PRODUCTION ASSOCIATES, INC.
 280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
 GROUNDWATER CONTOUR INTERVAL = 5'
 TOPOGRAPHIC CONTOUR INTERVAL = 5'
 WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
220 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
GROUNDWATER CONTOUR INTERVAL = 5'
TOPOGRAPHIC CONTOUR INTERVAL = 2'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NORTH



NAMES	DATE	DATUM	M.S.L.
DRAWN: J.F.M.	May, 1994	DATUM:	M.S.L.
DESIGN:		CONTOUR INTERVAL:	As Noted
PROJ. MGR.: D.W.W.		U.S.G.S. QUAD:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:			
	1"=300'		

RUST ENVIRONMENT & INFRASTRUCTURE

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(717) 795-8280 Fax

FIGURE 2-4
GROUNDWATER ELEVATION MAP

JUNE 7, 1993

NGK METALS CORPORATION

Pennsylvania

CAD FILE NAME: CONTFULLSITE6-7-93

3.0 AQUIFER TEST ANALYSIS

3.1 INTRODUCTION

Based on previous investigations, seven additional on-site wells were installed to provide appropriate data used to establish flow characteristics for the pumping and containment of contaminated groundwater, should they be included in the overall site well network of groundwater extraction wells. Specifically, these wells were installed to measure drawdown effects caused by pumping of select wells. The monitor wells were spaced with the intent that areas of influence could be sufficiently delineated.

After the new wells were installed and developed, informal step-drawdown tests were conducted on wells considered appropriate for use as potential groundwater recovery wells. New wells DW-27, DW-28, DW-29 and DW-32 were step-tested to evaluate well performance and to select an appropriate pumping rate for drawdown tests. These wells were selected based on the approximate well yields, which were estimated at the time of drilling and proximity to known source areas. In addition, step-drawdown tests were also completed on previously existing wells SW-8, DW-12 and DW-13, located on the southern portion of the site. These wells had not been previously tested and, because of their location and estimated yield, were anticipated to be included in the network of groundwater recovery wells based on pump test performance and results. Finally, after each well was step tested a drawdown/recovery test was performed and analyzed to evaluate the respective areas of influence. These areas of influence are key elements in the design of an appropriate and effective network of groundwater recovery wells that results in the prevention of off-site migration of contaminated groundwater.

3.2 STEP-DRAWDOWN TESTING

Prior to each of the respective drawdown tests, each well was step-drawdown tested at variable pumping rates. The data generated provided for an initial evaluation of the performance of each respective pumping well. A cursory review of each test is discussed below, and focuses on the actual performance of the respective pumping well rather than presenting a comprehensive quantitative analysis of each of the individual step-drawdown tests. The ultimate goal of each step-drawdown test was to establish optimal pumping rates that could be sustained for the respective minimum 3-day drawdown test planned, and result in maximum amount of drawdown in monitored observation wells.

3.2.1 SW-8

During the step-drawdown test, pumping rates of 10, 20, 30 and 40 gpm were selected to evaluate well performance. Each step was run for 30 minutes except for the 40 gpm test, which lasted for 10 minutes. The water level dropped to the pump intake during the 40 gpm test and



the pumping rate dropped to approximately 30 gpm. The test was terminated at this point. The test data indicated that the well was capable of sustaining a flow rate of approximately 30 gpm, which would result in maximum drawdown within the well. It was determined that the well could be stressed at this rate for the desired minimum 3-day period. A pumping rate of 30 gpm for the drawdown test was chosen.

3.2.2 DW-12

Pumping rates of 30, 60 and 96 gpm were chosen to evaluate well performance for well DW-12. The first step lasted nearly 60 minutes while the last two steps ran for roughly 30 minutes. The 96 gpm rate was the highest achievable with the available pump. The increased pumping rate resulted in no additional drawdown. Therefore, based on these results and the well yield estimated during the time of installation, a pumping rate of 120 gpm was selected for the drawdown test.

3.2.3 DW-13

Based on the estimated well yield determined during well installation, step-drawdown pumping rates of 60 and 96 gpm were chosen to evaluate well performance. The 96 gpm rate was the highest achievable with the available pump. The well was expected to sustain this pumping rate throughout the desired minimum three-day drawdown test period.

3.2.4 DW-27

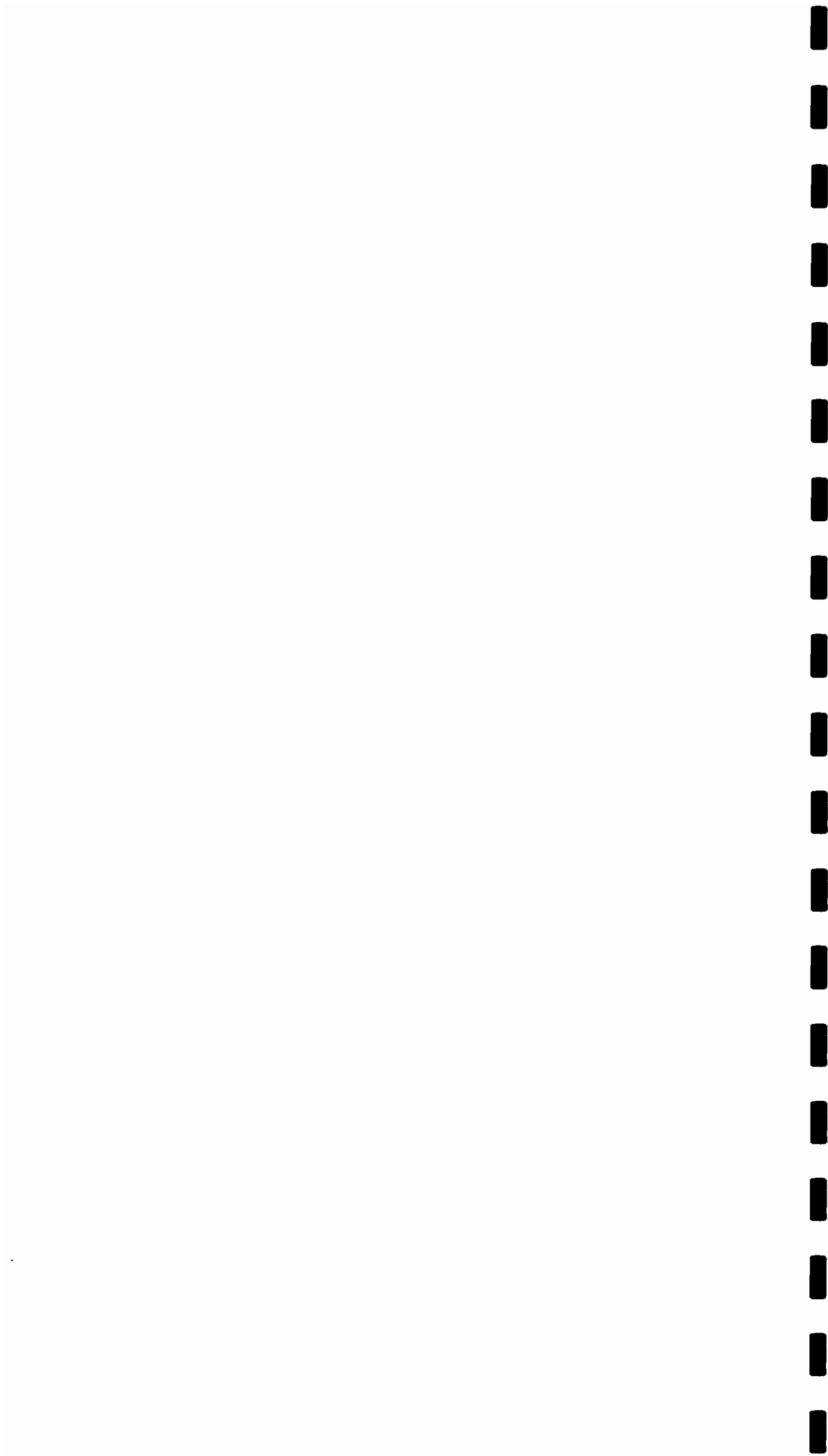
The performance of well DW-27 was evaluated for variable pumping rates of 15, 30, 45, 60, 75 and 92 gpm. The response of the well to these rates over 60 minute intervals indicated that the well was capable of sustaining a flow rate of at least 90 gpm for the drawdown test.

3.2.5 DW-28

Well DW-28 was step-drawdown tested at pumping rates of 9, 18 and 27 gpm. The pumping rates chosen were based on an initial estimated well yield of approximately 10 gpm. Test results indicated that the well could sustain a flow rate less than 9 gpm for the desired three-day drawdown test. A flow rate of 8 gpm was chosen.

3.2.6 DW-29

A step-drawdown test of varying rates was completed to evaluate well performance. Based on well yield estimates, DW-29 was tested at 60 and 98 gpm for approximately 30 minutes each step. Based on the water level response to each pumping rate, a pump capable of greater pumping rates was deemed necessary. The step-drawdown test results indicated that the well was capable of sustaining a pumping rate of greater than 98 gpm. A pump capable of up to 150 gpm was used during the drawdown test.



3.2.7 DW-32

Well yield estimated during the time of well drilling and installation was approximately 10-20 gpm. The step-drawdown test was performed at 5 and 7 gpm. The desired 10 gpm flow rate for the second step was not achieved due to pump limitations. Significant drawdown occurred even at 7 gpm. Therefore, initial well yield estimates were higher than actual well yield. A pumping rate of 9 gpm was selected for the drawdown test after a larger pump was installed.

3.3 DRAWDOWN/RECOVERY TESTING

After the respective step-drawdown tests were completed to evaluate the performance of each individual well, a drawdown test was conducted and immediately followed by a recovery test. The primary purpose of drawdown/recovery testing the potential groundwater recovery wells was to collect water level response data, which were used to select wells appropriate for use in a groundwater hydraulic containment system. Each drawdown test was performed over a minimum of approximately 72 hours. Drawdown tests of a duration of over a three-day period were expected to provide sufficient data to delineate areas of influence, degree of influence, and evaluate aquifer behavior characteristics. These data are essential for the development of an effective and efficient groundwater recovery well network. Pump test data are included in Appendix B.

Well DW-13 was tested for nearly seven days and the drawdown test on DW-12 lasted for approximately five days. Drawdown tests for wells DW-27 and DW-32 lasted four days while SW-8, DW-28 and DW-29 were tested for three days.

Graphical displays of pump drawdown test results are presented with each individual well test discussion that follows. Where appropriate, the respective measured drawdowns have been corrected and are plotted to account for natural area-wide groundwater level trends. The graphs typically reflect natural draining of the aquifer during periods of little precipitation or periods of infiltration due to seasonal precipitation events. A decline in water levels is denoted graphically by a negative-sloped line and a rise in water levels by a positive-sloped line (water levels versus time). Figures 1 through 7 in Appendix C show the pre-test water levels for pump tests on wells SW-8, DW-12, DW-13, DW-27, DW-28, DW-29, and DW-32.

Groundwater level data collected during drawdown/recovery testing of wells SW-8, DW-12, DW-13, DW-28, and DW-29 were primarily affected by naturally declining water levels. As a result, the corrected drawdowns are generally less than the measured drawdowns. Conversely, while drawdown/recovery testing wells DW-27 and DW-32, the water level trend was variable and drawdown adjustments were not appropriate. Corrections were only made when the water level trends continue throughout the entire duration of the pump test without significant variability. Therefore, drawdowns were not corrected for wells DW-27 and 32. The variable water level data were coincident with precipitation events coupled with a significant snow pack melt. The changes in slope on Figures 6 and 7 correspond to the variable groundwater recharge



and discharge episodes. Corrected and uncorrected drawdowns for the respective pump tests are summarized on Table 3-1.

The effects of conducting step-drawdown tests prior to the startup of respective drawdown (pump) tests is seen on some of the graphs in Appendix B. In these instances, water level correction factors, when applied, were determined by pre-step drawdown test trends.

3.3.1 SW-8

Drawdown/recovery testing was performed by withdrawing groundwater from well SW-8 at an average rate of approximately 28 gpm. The pump test was conducted from August 16 to August 19, 1993. The initial pumping rate was set at 30 gpm, and after approximately 1210 minutes of pumping the rate fell to roughly 25 gpm. At this point the water level had dropped within the well to the pump intake, but the 25 gpm yield was sustained. Drawdown testing lasted for a total of 4356 minutes. Drawdown in well SW-8 reached a maximum of nearly 14 feet. This drawdown was generally maintained until the termination of the test. Wells DW-8, DW-12, DW-13, SW-7, SW-24, SW-P-1, Well 1, Well 3, and Well 4 were also monitored. Figures 3-1 and 3-2 illustrate the water level responses for each of the observed wells.

Water levels in monitor wells Well 3, DW-13 and DW-8 showed the most decline due to pumping. Corrected drawdowns in these wells were 1.30, 1.25, and 1.15 feet, respectively. Well 4 showed a decline of 0.25 feet, which is possibly due to pumping. Water levels in monitor wells SW-24 and SW-P-1, that are located just off-site towards the southwest, were rising. Rising water levels are contrary to the expected response due to pumping. Therefore, these two shallow wells were unaffected by pumping of well SW-8. Although, the cyclic pattern for SW-24 plot suggests that this well may be impacted by a nearby pumping well. Reportedly, there are groundwater production wells located within the tank farm located less than 2000 feet south of well SW-24. Pre-test groundwater elevation data are shown on Figure 3-3. In comparison, the maximum drawdown groundwater elevations that resulted from the pumping of SW-8 are shown on Figure 3-4.

The water level drop in Well 3 was slightly more than in observation wells DW-8 and DW-13. Well 3, like pumping well SW-8, is set within the shallow aquifer system (i.e. less than 100 feet deep). During the early portion of the drawdown test, at about 900 minutes, the water level in Well 3 rose nearly 0.5 feet, peaked at approximately 1200 minutes then continued to decline until the recovery portion of the test. This pattern may be indicative of period of infiltration caused by a precipitation event that occurred approximately two days earlier.

The remaining wells, DW-8 and DW-13 are constructed within the deep aquifer system, which is considered more than 100 feet below the ground surface. The corrected drawdown data from pumping SW-8 are summarized below in Table 3-2.

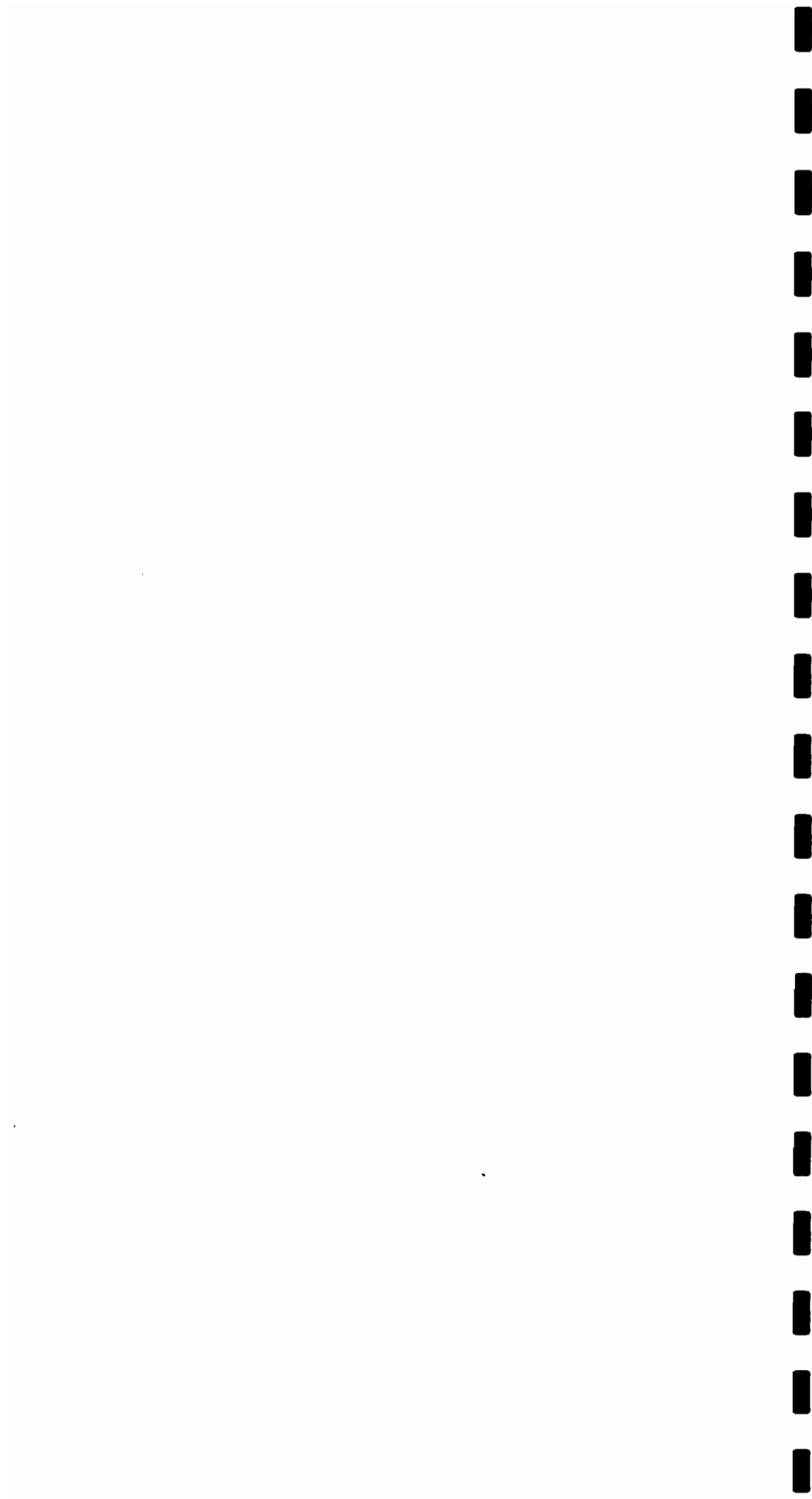
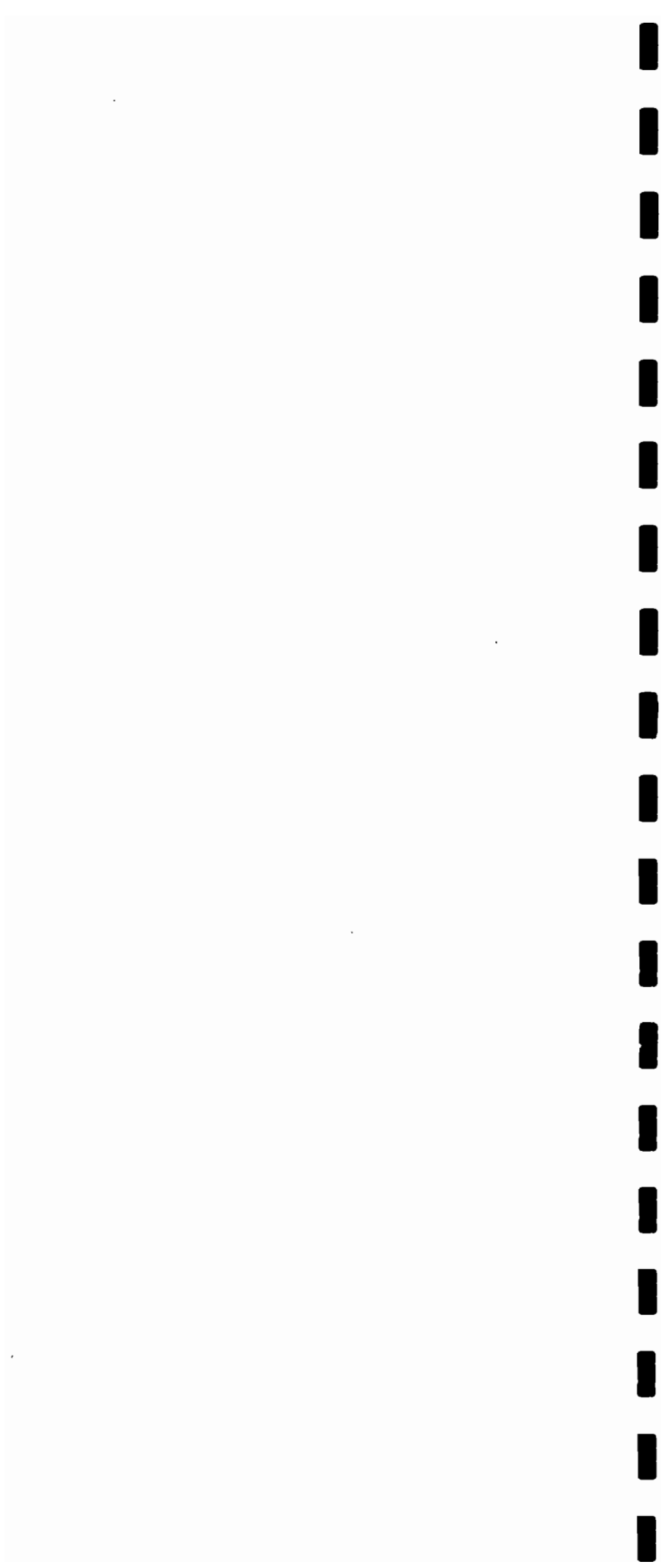


TABLE 3-1
DRAWDOWN DATA SUMMARY

PUMPING WELL SW-8			PUMPING WELL DW-12			PUMPING WELL DW-13		
Well	Drawdown	Corrected DD	Well	Drawdown	Corrected DD	Well	Drawdown	Corrected DD
SW-8	14.04	13.69	DW-12	42.86	42.11	DW-13	38.29	38.29
Well 4	0.62	0.25	SW-12	3.96	3.36	Well 3	19.01	19.01
DW-13	1.67	1.25	Well 4	6.49	6.16	DW-12	2.65	1.24
Well 1	0.26	-0.13	Well 1	12.04	11.73	Well 1	2.38	1.01
DW-8	1.57	1.15	DW-13	2.74	2.33	Well 4	3.94	2.39
Well 3	1.70	1.30	SW-5	-0.25	-0.97	SW-8	7.10	7.10
SW-7	0.42	-0.04	DW-5	0.17	-0.60	DW-8	9.07	9.07
DW-12	0.16	-0.26	SW-6	0.35	-0.03	SW-5	0.22	-1.08
SW-P-1	-0.11	-0.11	SW-7	1.17	0.72	DW-5	0.24	-1.02
SW-24	-3.28	-3.28	SW-8	2.12	1.81	SW-6	1.89	1.89
			DW-8	1.20	0.81	SW-7	2.30	0.85
			SW-9	0.66	-0.03	SW-9	1.64	0.23
			DW-9	1.08	0.62	DW-9	1.30	0.07
			SW-10	-0.08	-1.03	SW-10	0.72	-0.59
			DW-10	1.06	-0.11	DW-10	-0.19	-1.50
			SW-19	0.63	-0.01	SW-12	1.58	0.48
			SW-20	0.60	-0.04	SW-18	1.63	0.06
			SW-24	-2.93	-2.93	SW-19	1.62	0.21
			SW-P-1	2.48	2.48	SW-20	1.57	-0.07
			Well 2	0.86	-0.01	SW-24	-4.57	-4.57
			Well 3	2.68	2.24	Well 2	2.06	0.32
						SW-P-1	-0.69	-0.69
PUMPING WELL DW-27			PUMPING WELL DW-28			PUMPING WELL DW-29		
Well	Drawdown	Corrected DD	Well	Drawdown	Corrected DD	Well	Drawdown	Corrected DD
DW-27	32.84	32.84	DW-28	40.40	40.40	DW-29	41.39	41.28
SW-16	-2.71	-2.71	SW-15	0.56	0.24	SW-15	0.45	0.21
DW-28	7.36	7.36	SW-23	0.91	0.91	SW-23	3.66	2.95
SW-22	0.28	0.28	DW-15	0.51	0.51	DW-15	6.17	6.06
SW-15	-0.70	-0.70	DW-27	0.72	0.52	DW-28	2.21	1.57
DW-15	2.03	2.03	SW-22	0.82	0.41	DW-30	3.90	3.66
SW-23	3.06	3.06	SW-29	-0.13	-0.13	SW-14	2.78	2.58
DW-16	-0.55	-0.55	SW-5	0.89	0.02	SW-5	1.45	-0.15
			DW-5	0.88	0.05	DW-5	1.21	-0.25
			SW-6	0.74	-0.01	SW-11	1.10	-0.03
			SW-7	0.35	-0.08	SW-16	0.36	-0.02
			SW-11	0.83	-0.05	DW-16	0.57	0.30
			SW-14	0.03	0.03	SW-17	0.27	-0.02
			SW-16	0.35	0.05	DW-17	0.42	0.18
			DW-16	0.38	0.15	SW-21	0.37	0.02
			SW-17	0.34	0.07	SW-22	0.64	0.34
			DW-17	0.42	-0.02	DW-25	0.02	-0.18
			SW-21	7.79	7.06	DW-27	1.07	0.31
			DW-25	-0.16	-0.16	DW-31	0.37	0.13
			DW-30	-0.07	-0.07			
			DW-31	1.29	0.80			
PUMPING WELL DW-32								
Well	Drawdown	Corrected DD						
DW-32	63.19	63.19						
DW-13	0.71	0.71						
Well 3	0.70	0.70						
SW-8	0.62	0.62						
DW-8	0.05	0.05						
SW-7	2.28	2.28						
Well 2	0.76	0.76						
Well 4	0.77	0.77						



AR360300

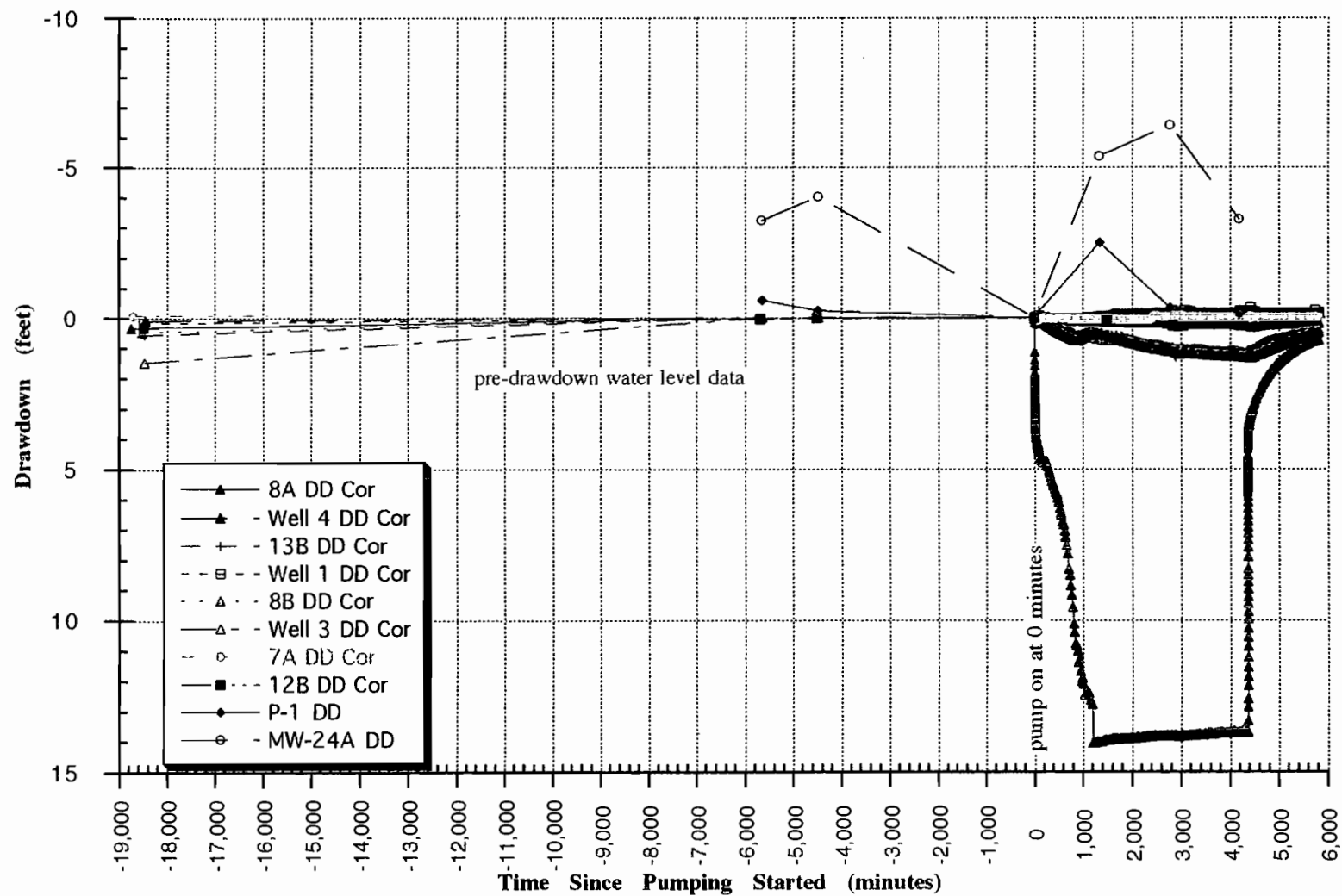
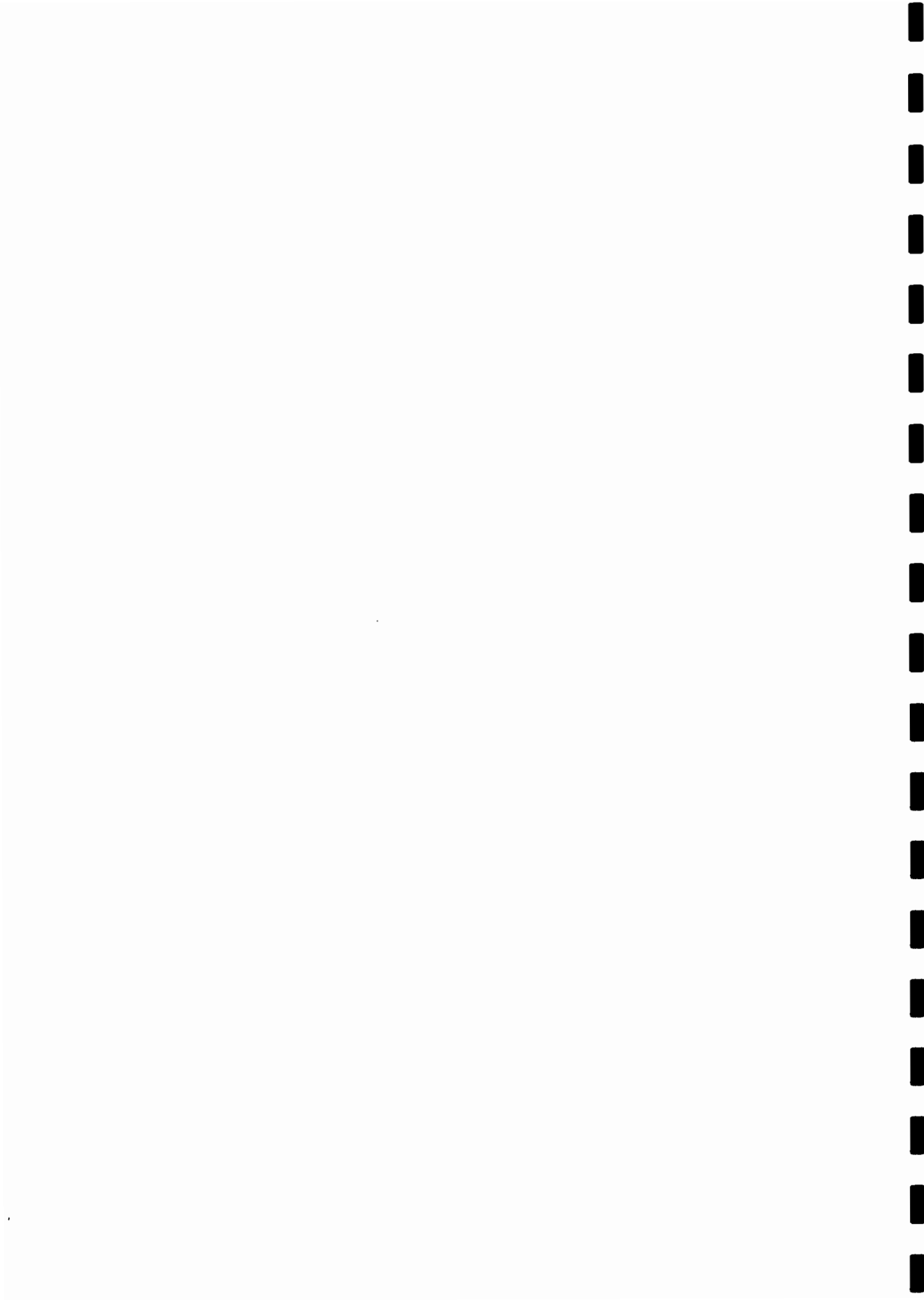


Figure 3-1
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well MW-8A



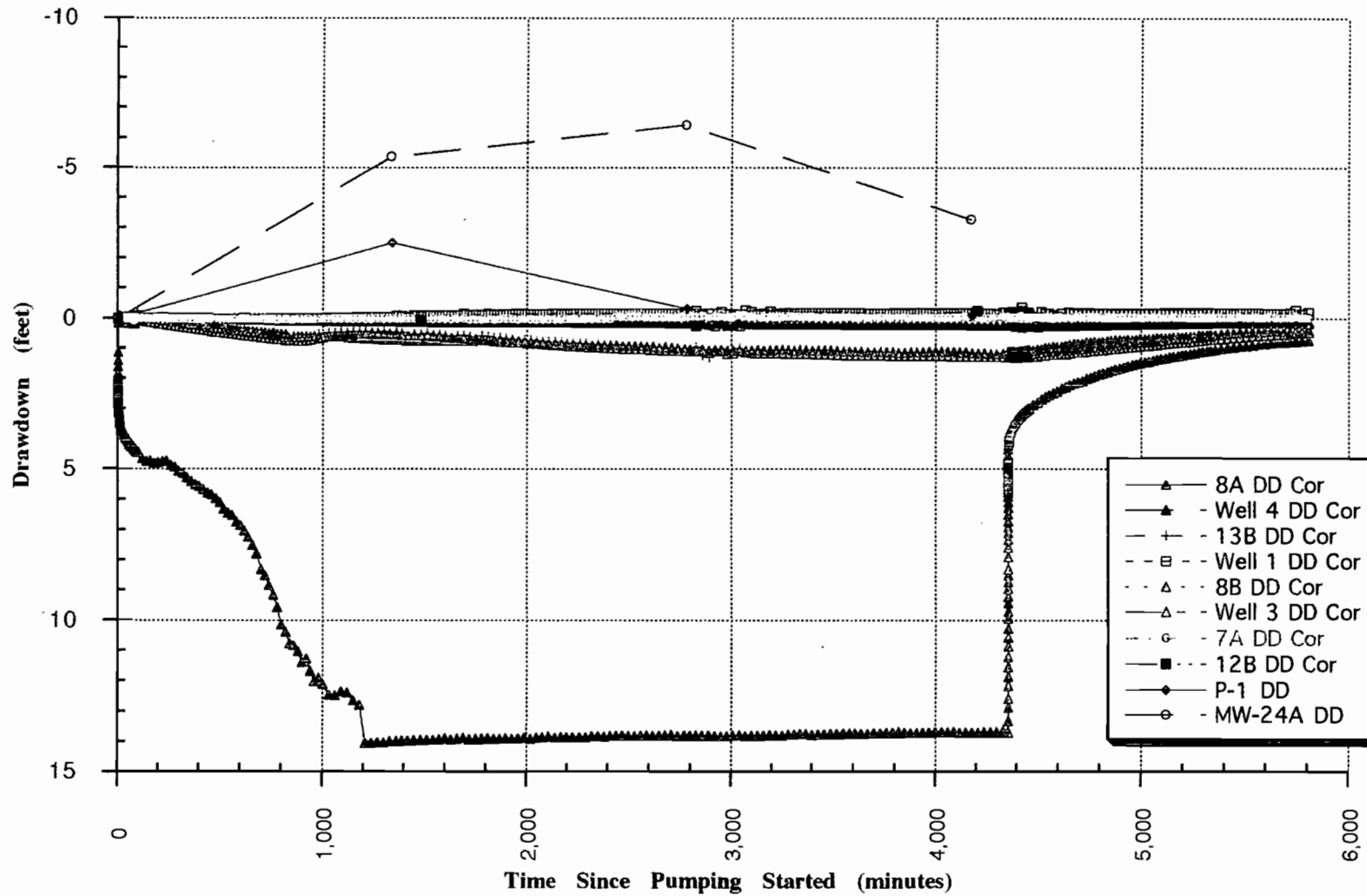


Figure 3-2
Drawdown/Recovery Test Graph
for Pumping Well MW-8A

AR360301

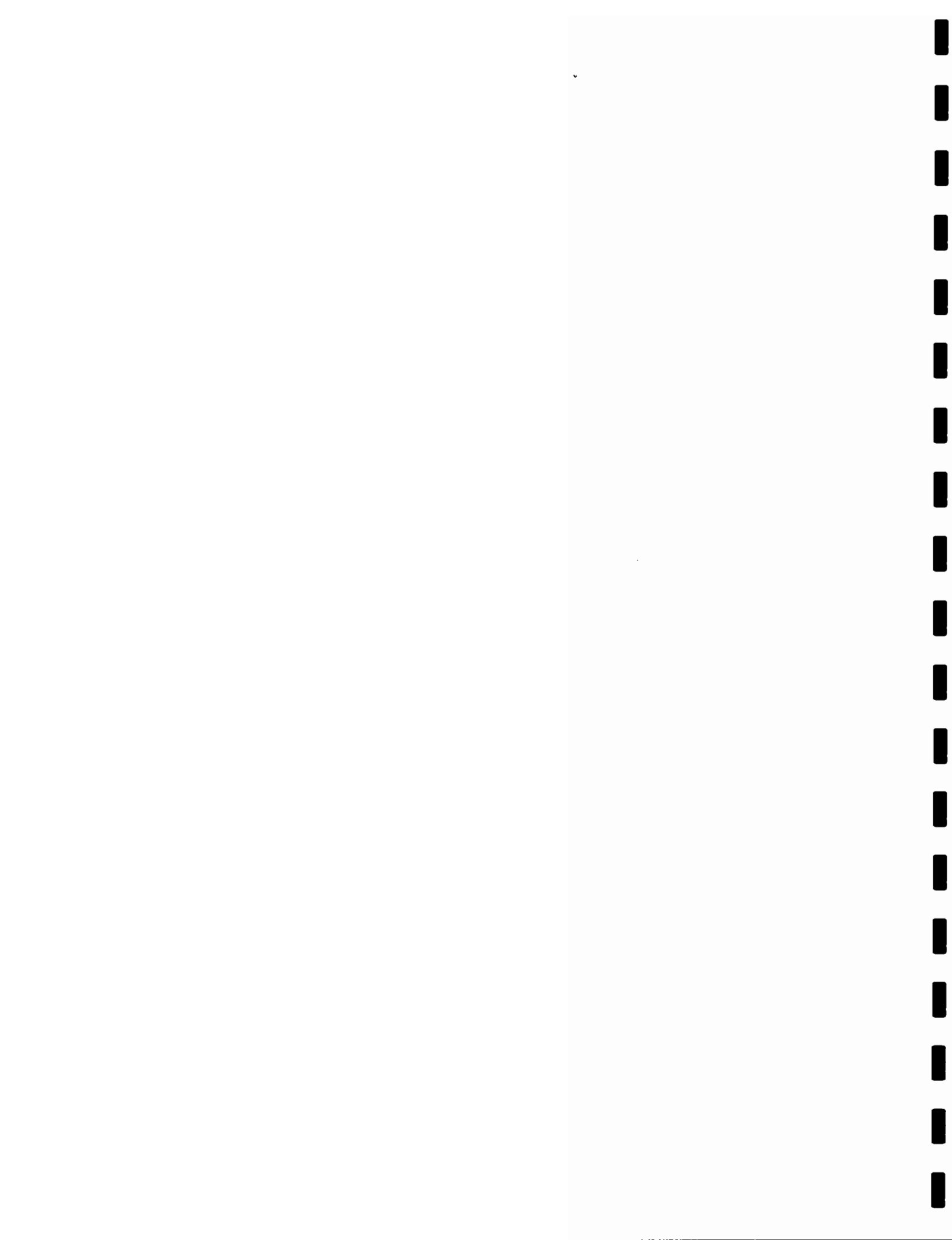




TABLE 3-2
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL SW-8

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM SW-8 (ft.)</u>
SW-8	13.69	0.33
DW-8	1.15	15
Well 3	1.30	223
DW-13	1.25	250
Well 4	0.25	305

Upon completion of the drawdown test, water level recovery data were collected. The recovery test terminated after the water level reached approximately 92% of total recovery. One small rain event of 0.17 inches occurred on the day after pumping began. No other precipitation fell during the remaining drawdown test or subsequent recovery test. Available precipitation data from the nearest reporting weather station, which is located at the Allentown-Bethlehem-Easton airport approximately 25 miles to the northeast, along with a plot of these data are found in Appendix D.

3.3.2 DW-12

Drawdown/recovery testing was performed by withdrawing groundwater from well DW-12 at an average rate of 105 gpm. The drawdown test ran from July 15 to July 19, 1993. The initial pumping rate was set at 120 gpm, and gradually the rate fell to roughly 110 gpm at the end of the test with periodic lows of 95 gpm. Well DW-12 is a 6-inch open rock well with open interval (uncased) from 100 feet to 160 feet. Groundwater extracted from the well during prior sampling and well development events has historically been turbid. Available information indicates that the turbid conditions may likely continue as a result of extended pumping of this well because the open rock section intersects a muddy, clay-filled void from 155 to 160 feet. Therefore, as a precautionary measure, 4-inch diameter slotted PVC screen was lowered into the borehole prior to the drawdown tests on the well to reduce the risk of borehole collapse. In addition, the screen prevented any loose fragments of the surrounding formation from potentially passing through the pump, which would affect pump performance. A 4-inch diameter screen was the largest commonly available type that would accommodate the nominal borehole diameter. A centrifugal submersible pump capable of pumping up to 150 gpm was used to conduct the tests. This pump was selected because it would fit into the 4-inch diameter PVC, and provide an adequate flow rate for the drawdown test.

Because of limited space between the pump intake and the inner PVC screen surface, it is believed that groundwater flow was restricted during the drawdown test. As a result, recorded



drawdown within the screen was enhanced due to well inefficiency. The maximum recorded and corrected (for natural water level trend) drawdown was just slightly more than 42 feet. The actual drawdown, which was spot checked within the space between the screen and the borehole with an electric drop line monitoring device, showed a discrepancy from the recorded drawdown of approximately 20 feet. Several other water level checks were unreliable water levels due either to the probe hanging up or cascading water along the borehole, which produced false water level readings. The relationship between measured and recorded drawdowns was not linear, and therefore, not correctable. Irrespective of the actual drawdown, the sustained pumping of well DW-12 over a period of approximately 5650 minutes produced favorable results in terms of measurable drawdown in distant observation wells.

Water levels in a total of six monitor wells dropped more than one foot, and was due to pumping of well DW-12. Although the (corrected) drawdown in well DW-8 was less than one foot (0.81 feet), this drop is likely due to pumping DW-12. Piezometer P-1 dropped 2.24 feet, however, it is undetermined whether this is attributable to pumping DW-12. Drawdown results are shown on Figures 3-5 and 3-6. Recorded (corrected) drawdowns in shallow wells and deep wells are as follows:

TABLE 3-3
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-12

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-12 (ft.)</u>
DW-12	42.11	0.25
Well 1	11.73	76
SW-12	3.36	359
DW-13	2.33	391
Well 3	2.24	423
Well 4	6.16	409
DW-9	0.62	583
SW-8	1.81	617
DW-8	0.81	632
SW-7	0.72	723

The relationship of distance and groundwater elevations before the pump was turned on and near maximum drawdown in the pumping well are shown on Figures 3-7 and 3-8. The impact of pumping well DW-12 on the shallow and deep water level systems is shown by the inflection of the shallow water level contours and by the concentric closed deep water level contours.

A recovery test was conducted immediately after the completion of the drawdown test of well DW-12. The water level in DW-12 reached approximately 87% recovery before data logging



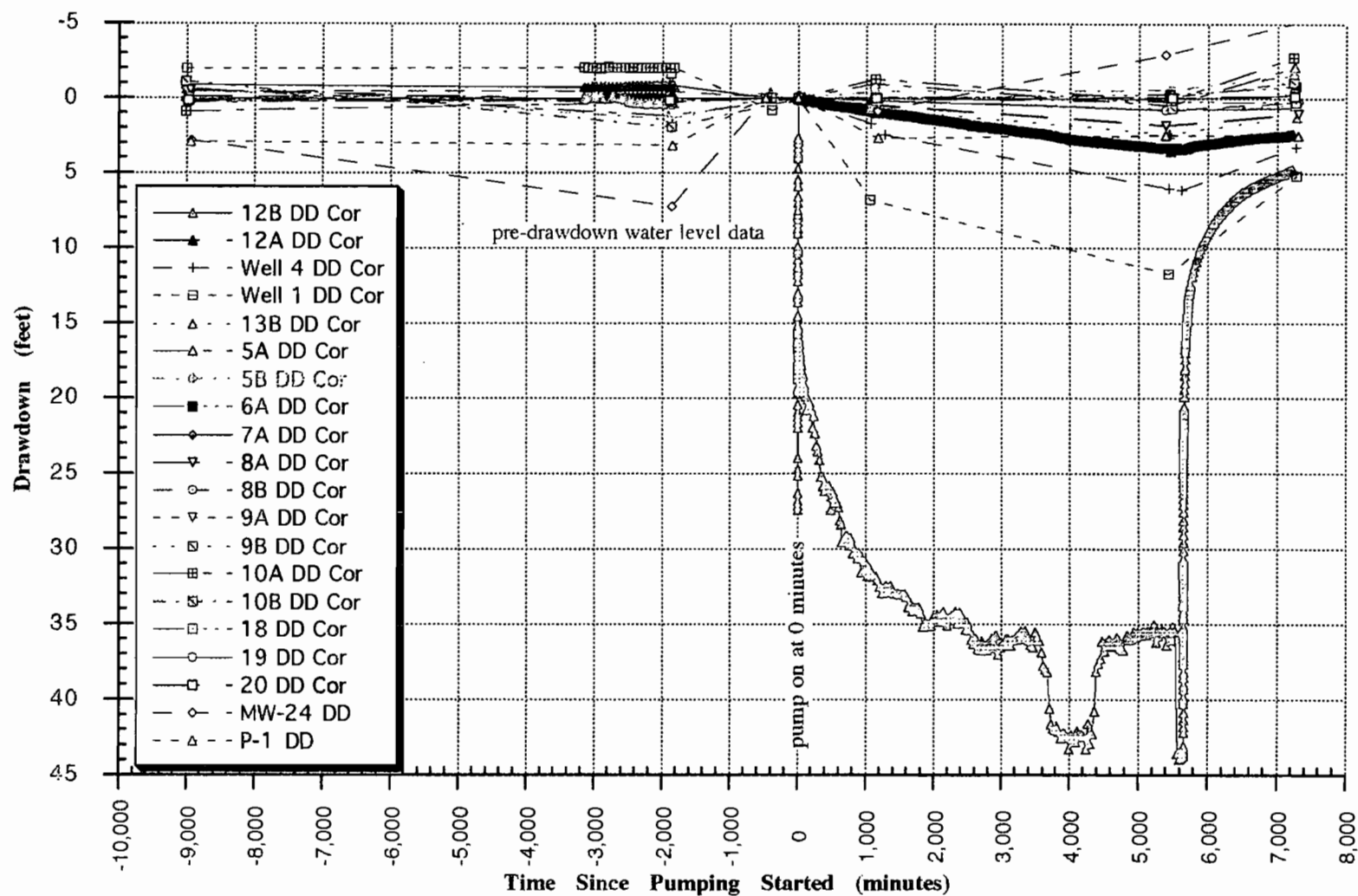
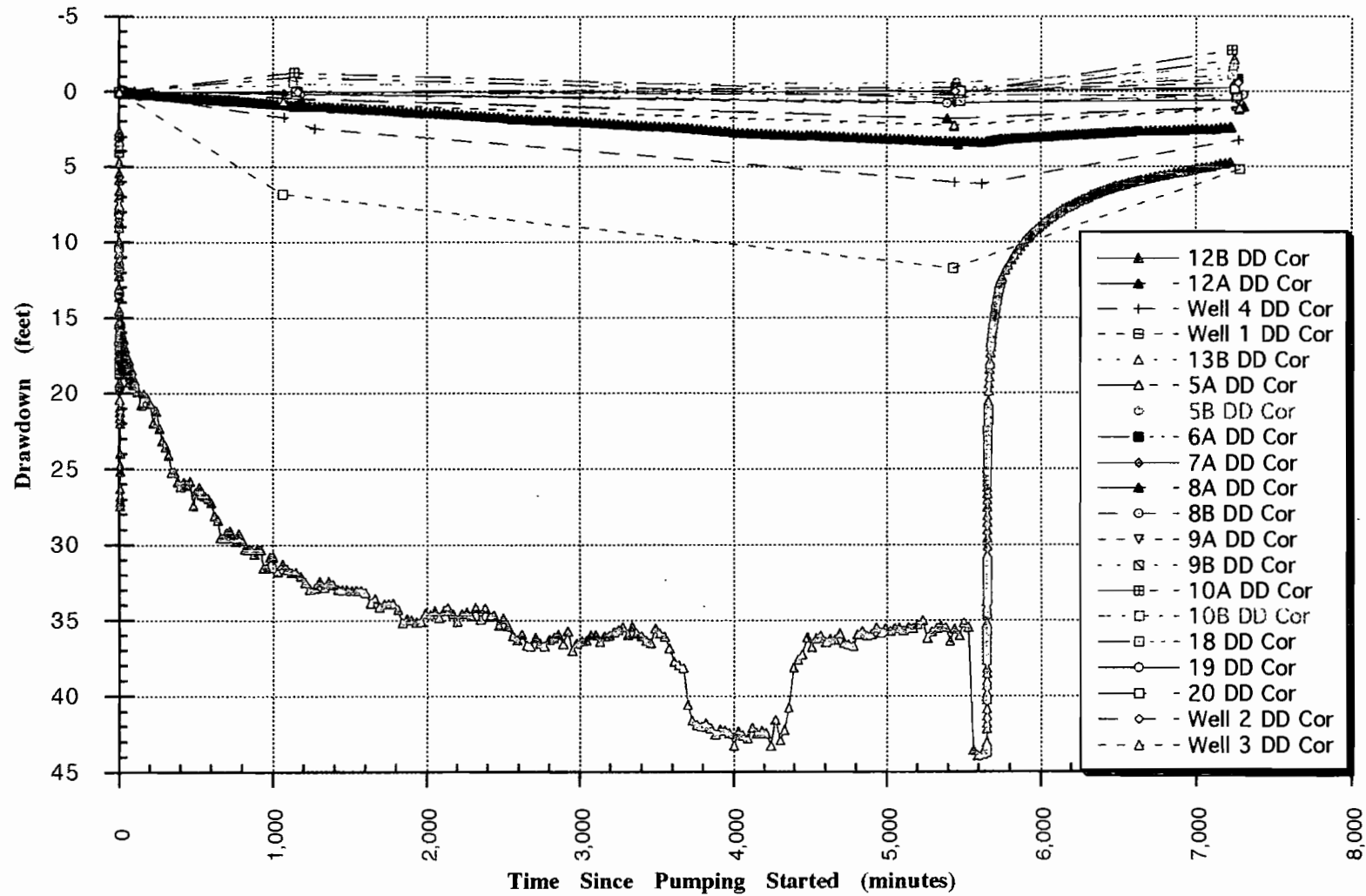
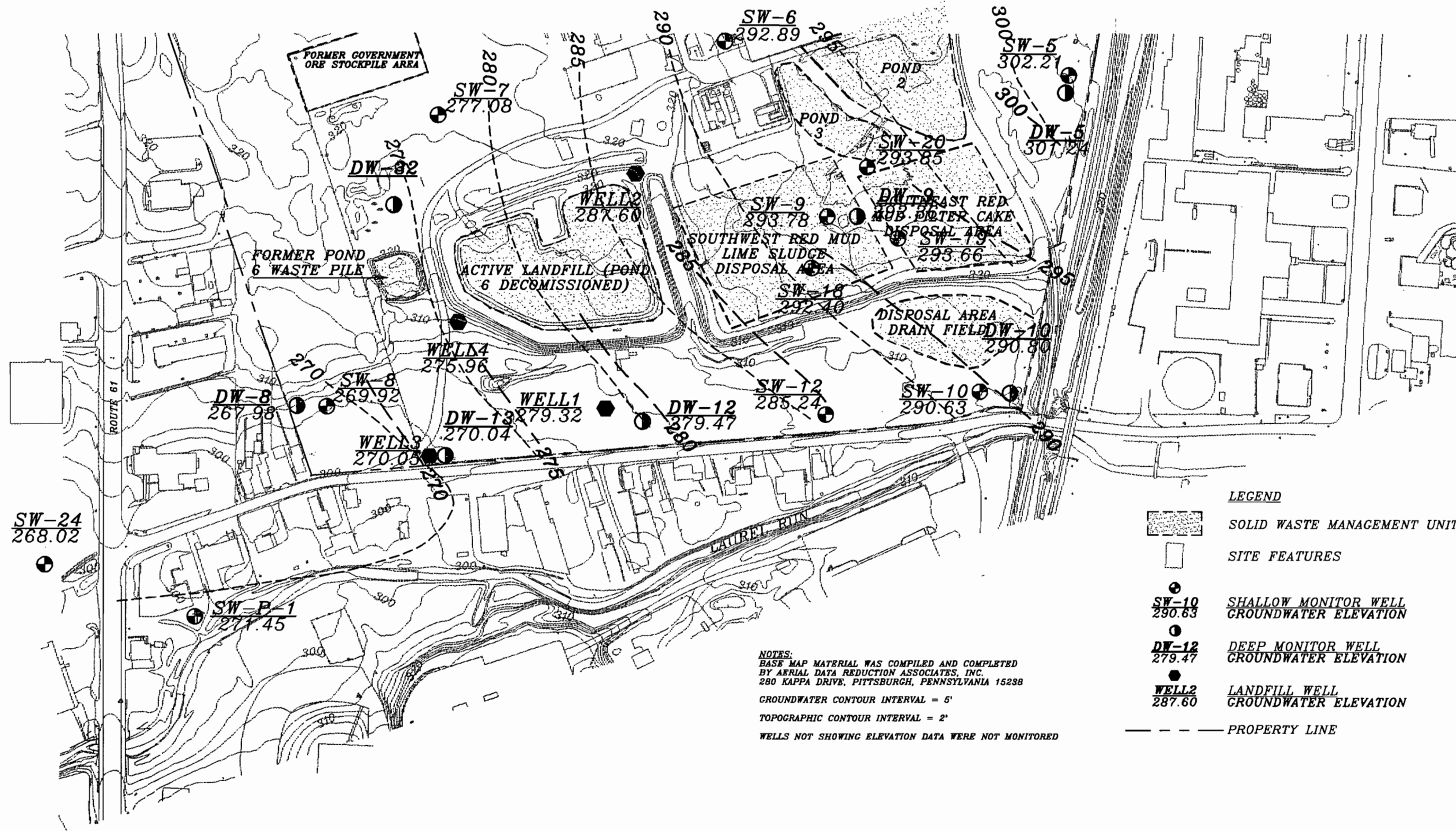


Figure 3-5
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well MW-12B

AR360306



AR360307



NOTES:
 BASE MAP MATERIAL WAS COMPILED AND COMPLETED
 BY AERIAL DATA REDUCTION ASSOCIATES, INC.
 280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
 GROUNDWATER CONTOUR INTERVAL = 5'
 TOPOGRAPHIC CONTOUR INTERVAL = 2'
 WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED

- LEGEND**
- SOLID WASTE MANAGEMENT UNIT
 - SITE FEATURES
 - SW-10** 290.63 SHALLOW MONITOR WELL GROUNDWATER ELEVATION
 - DW-12** 279.47 DEEP MONITOR WELL GROUNDWATER ELEVATION
 - WELL2** 287.60 LANDFILL WELL GROUNDWATER ELEVATION
 - PROPERTY LINE

NORTH

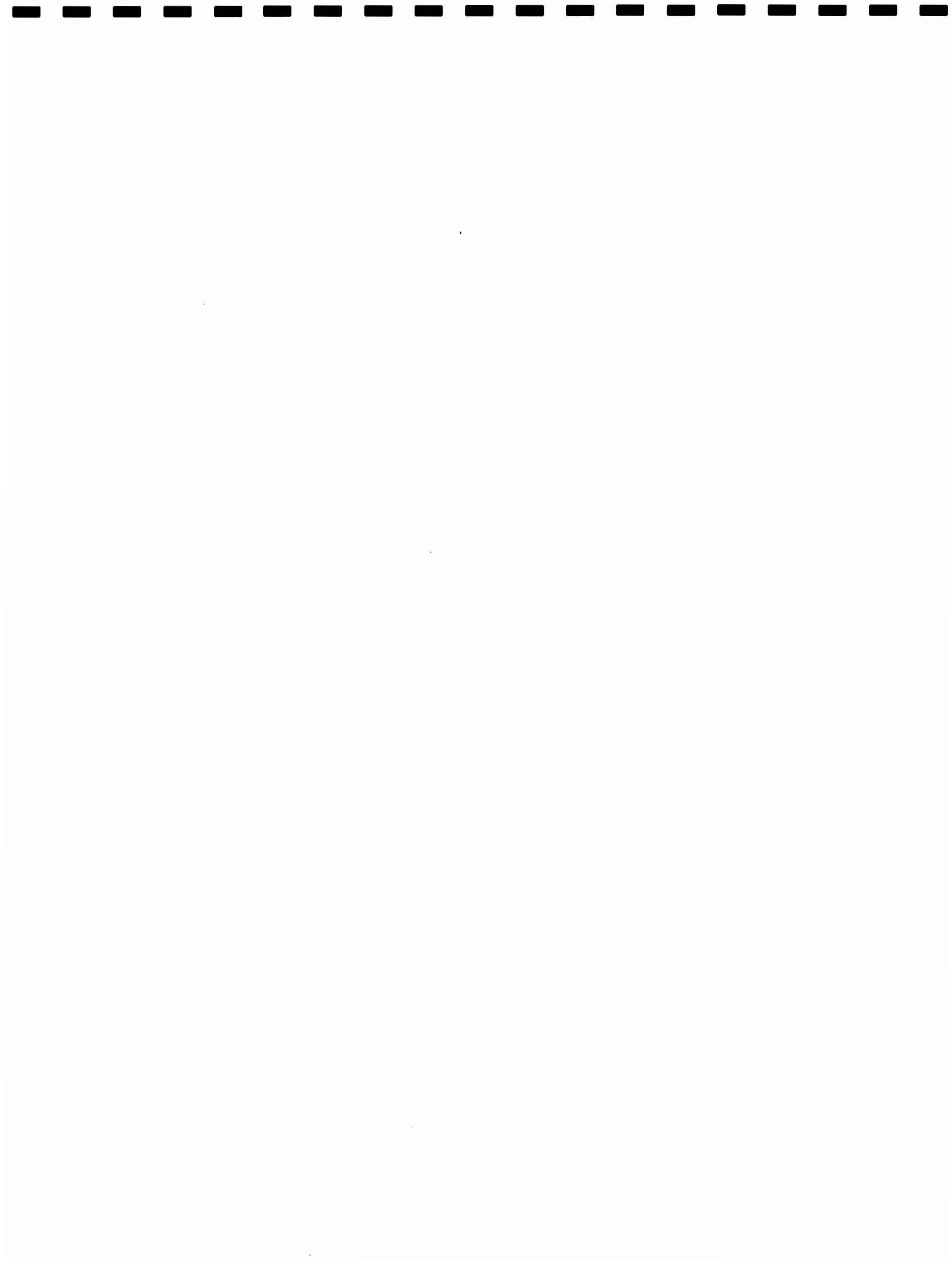
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DRAWN: J.F.M.		May, 1994		
DESIGN:			CONTOUR INTERVAL: As Noted	
PROJ. MGR.: D.V.V.			U.S.G.S. QUAD.: Temple	
PROJ. ENG.: C.M.S.				
CHECKED: J.J.P.				
SCALE:				

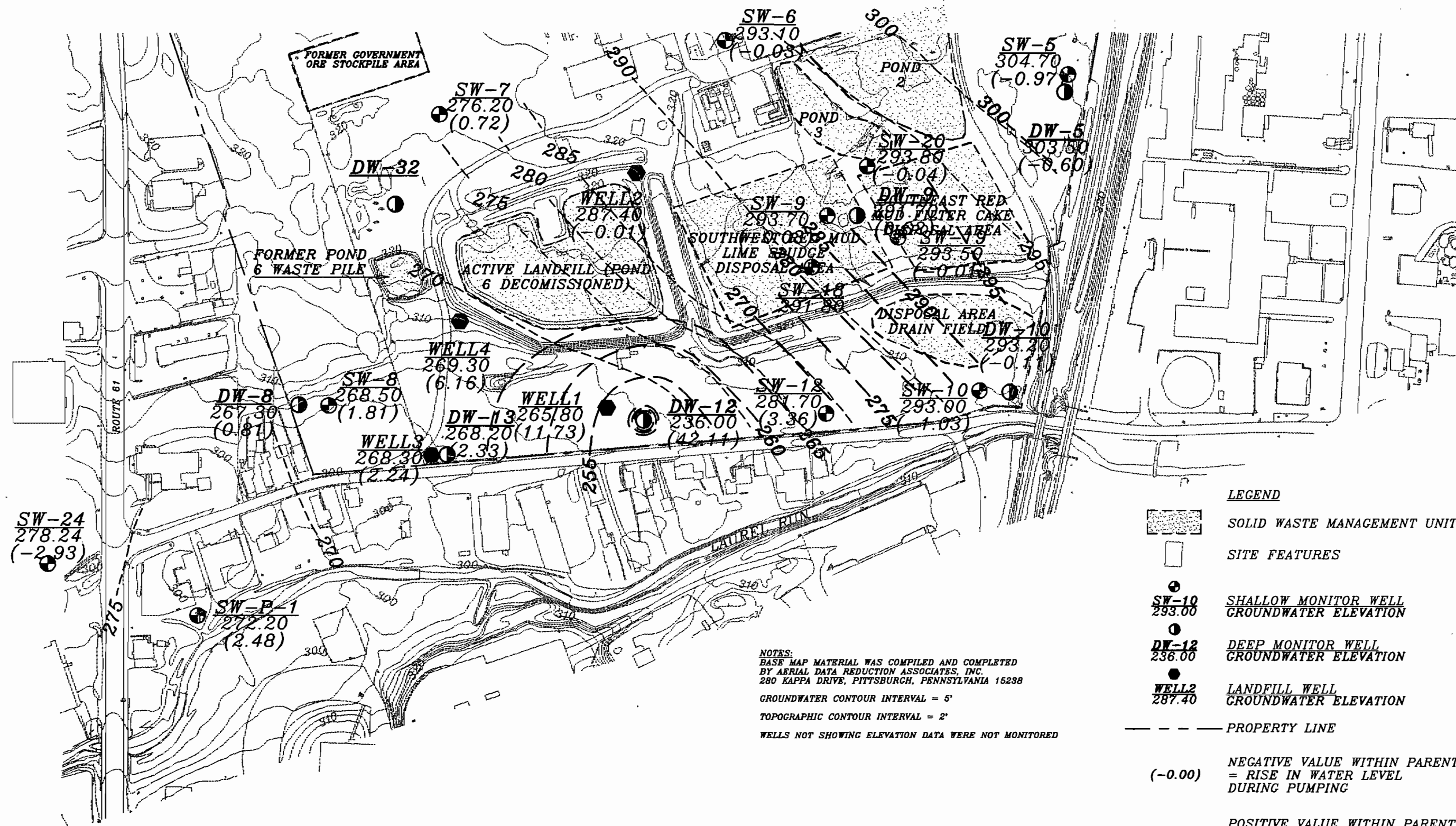
1"=200'

RUST ENVIRONMENT & INFRASTRUCTURE

2 Market Plaza Way
 Mechanicsburg, PA 17055
 (717) 796-8001
 (717) 796-8280 Fax

FIGURE 3-7
 GROUNDWATER ELEVATION MAP
 DW-12 JULY 14, 1993, PRE-TEST
 NGK METALS CORPORATION
 Berks County
 Pennsylvania





NORTH

NAMES		DATE	DATUM:	MSL.
DRAWN:	J.F.M.	May, 1994		
DESIGN:			CONTOUR INTERVAL:	As Noted
PROJ. MGR.:	D.V.V.		U.S.G.S. QUAD.:	Temple
PROJ. ENG.:	C.M.S.			
CHECKED:	J.J.P.			
SCALE:	1"=200'			

RUST ENVIRONMENT & INFRASTRUCTURE

2 Market Plaza Way
Mechanicsburg, PA 17055
(717) 796-8001
(717) 796-8280 Fax

FIGURE 3-8
GROUNDWATER ELEVATION MAP
DW-12 JULY 19, 1993, MAXIMUM DRAWDOWN
NGK METALS CORPORATION
Berks County Pennsylvania

CLIENT DWG. NO.
RUST DWG. NO.
PROJECT NUMBER 35325.300
DATE
REVISION NUMBER
SHEET NUMBER OF

CAD FILE NAME: CONTMAXDD12

AR360309



stopped. A significant rain event of 0.83 inches occurred on July 14, the day before the drawdown test began. Recorded water levels in observation wells monitored during the drawdown test do not appear to reflect this precipitation event. Another rain event of 1.07 inches occurred on July 18, which was the day before the pump was shut off. Water level recovery responses may have been enhanced due this storm event. Precipitation data are presented in Appendix D.

3.3.3 DW-13

Drawdown/recovery testing was performed on deep well DW-13 from June 14 to June 21, 1993. The drawdown test lasted approximately 9730 minutes at an average rate of 105 gpm. The total pumping time is estimated, since the pump was inadvertently shut off before the data logger could be immediately re-set to record groundwater recovery responses. The data logger was re-set sufficiently early, however, to record water level recovery beginning within an estimated 30 minutes of pump shut off. Water level response graphs for the drawdown and recovery tests are shown in Figures 3-9 and 3-10. Well DW-13, like well DW-12, is a 6-inch diameter open bedrock well. The open bedrock interval is from 105 to 165 feet below ground. Four-inch diameter PVC screen was used to maintain borehole integrity during pumping to prevent potential bedrock formation collapse around the pump.

Because of limited space between the pump intake and the inner PVC screen surface, it is believed that groundwater flow was restricted during the drawdown test. As a result, recorded drawdown within the screen was enhanced due to well inefficiency. The maximum recorded drawdown in the pumped well was just slightly more than 38 feet. In adjacent shallow Well 3, located only about 15 feet away, the drawdown was approximately 19 feet. Therefore, the actual drawdown in DW-13 is between 19 feet and 38 feet, but probably closer to 19 feet.

Water levels in a total of six monitor wells dropped more than one foot, and was due to pumping of well DW-13. The water level in well SW-7 dropped less than one foot (0.85 feet), however, and this corrected drawdown is likely from pumping of DW-13. Recorded (corrected) drawdowns in shallow wells and deep wells are as follows:

TABLE 3-4
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-13

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-13 (ft.)</u>
DW-13	38.29	0.25
Well 3	19.01	15
SW-8	7.10	250
Well 4	2.39	264
DW-8	9.07	265
Well 1	1.01	327
DW-12	1.24	391
SW-7	0.85	620



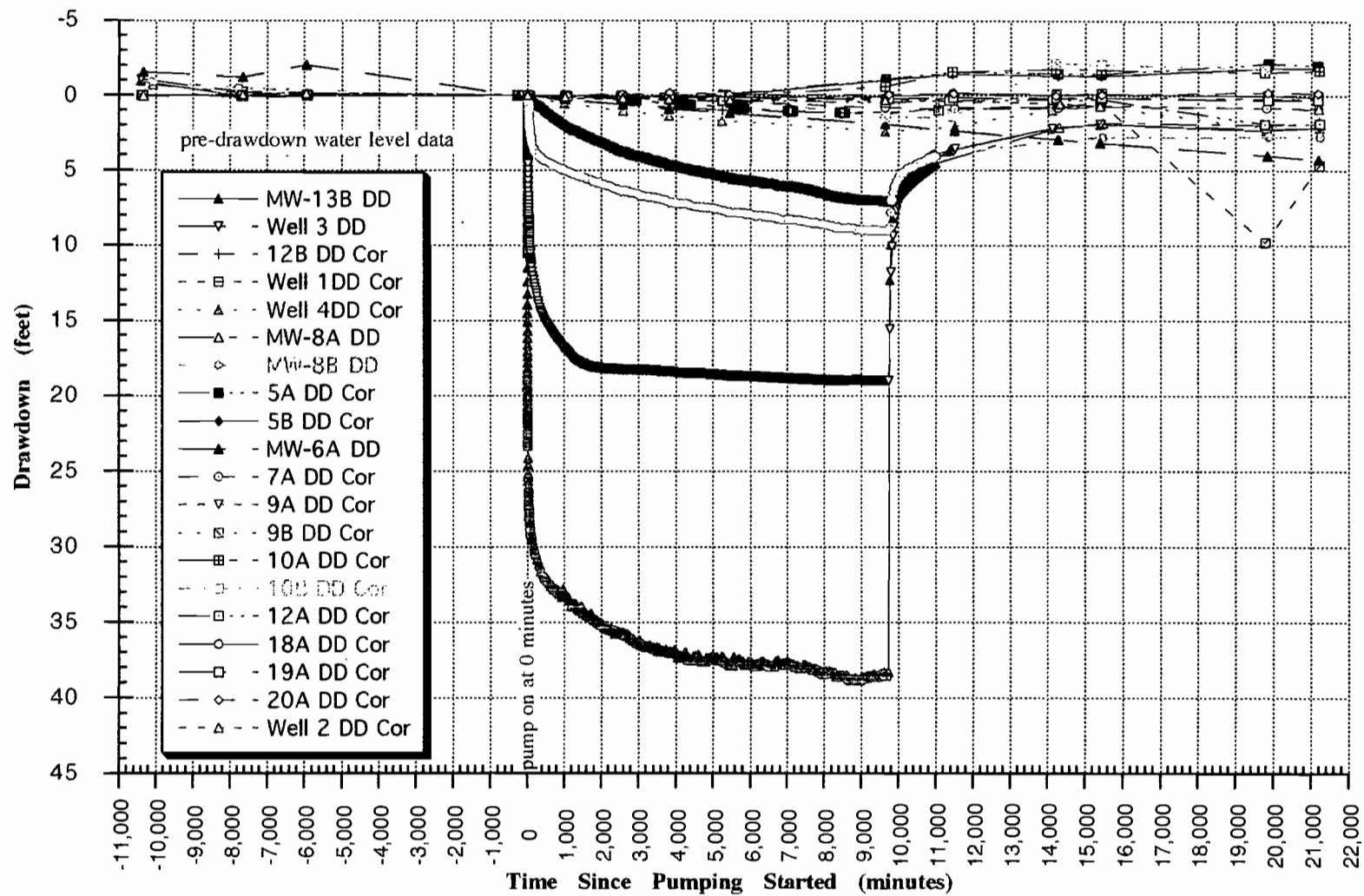
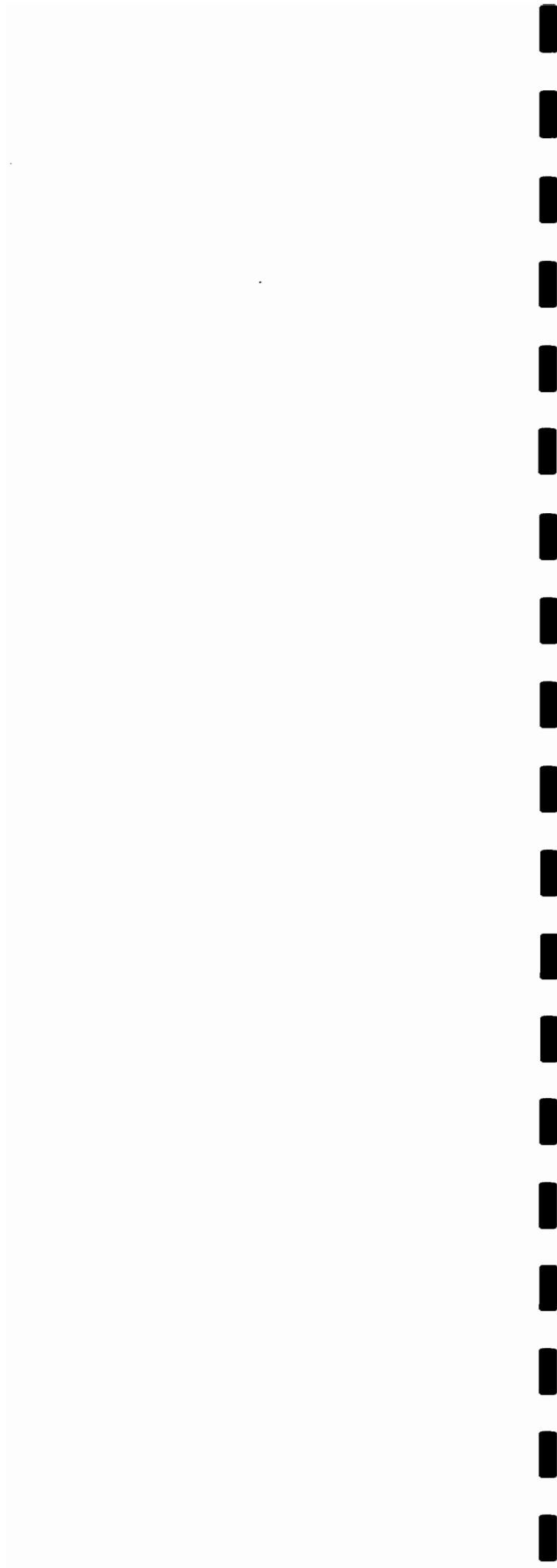


Figure 3-9
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well MW-13B

AR360311



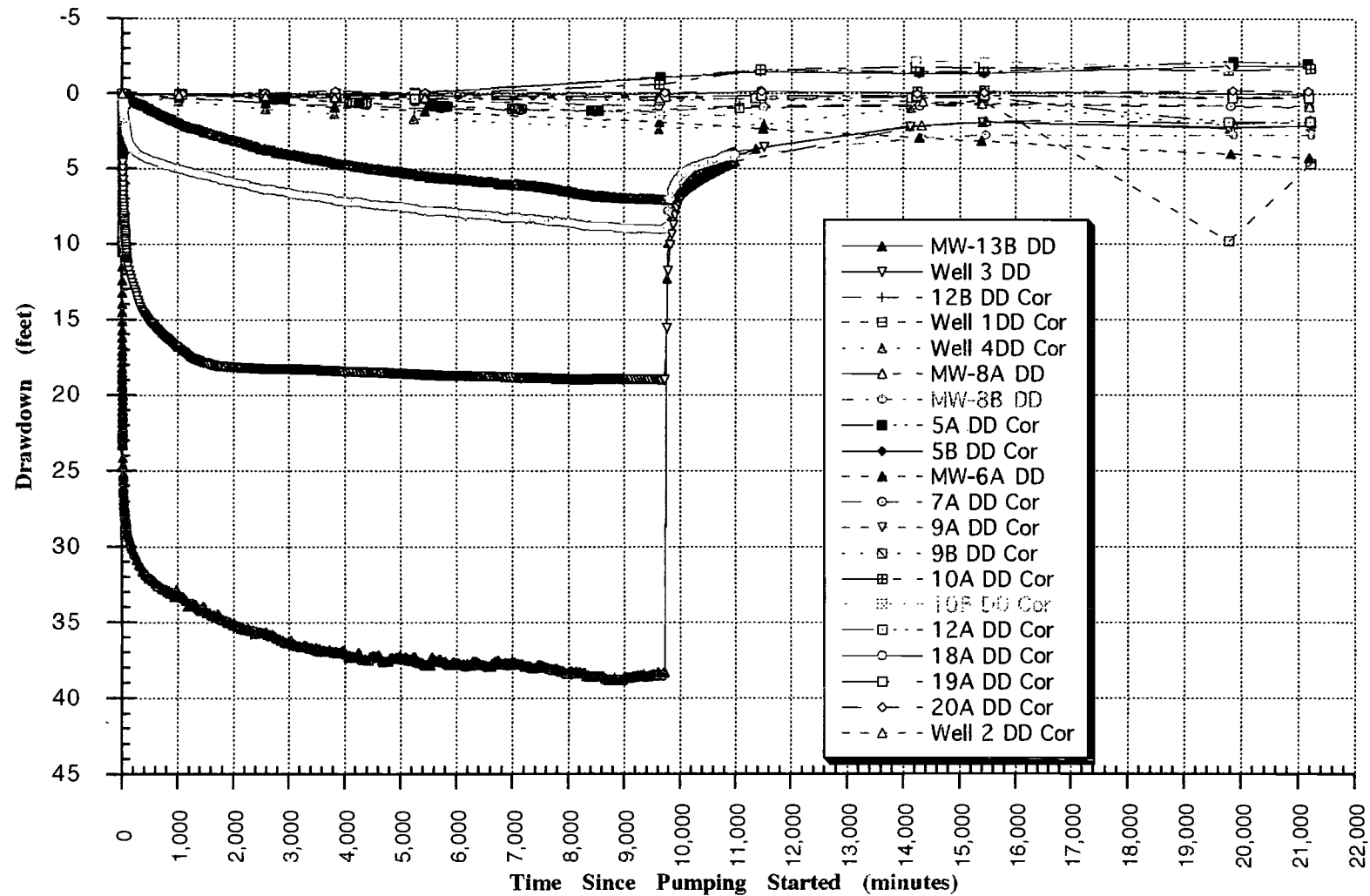
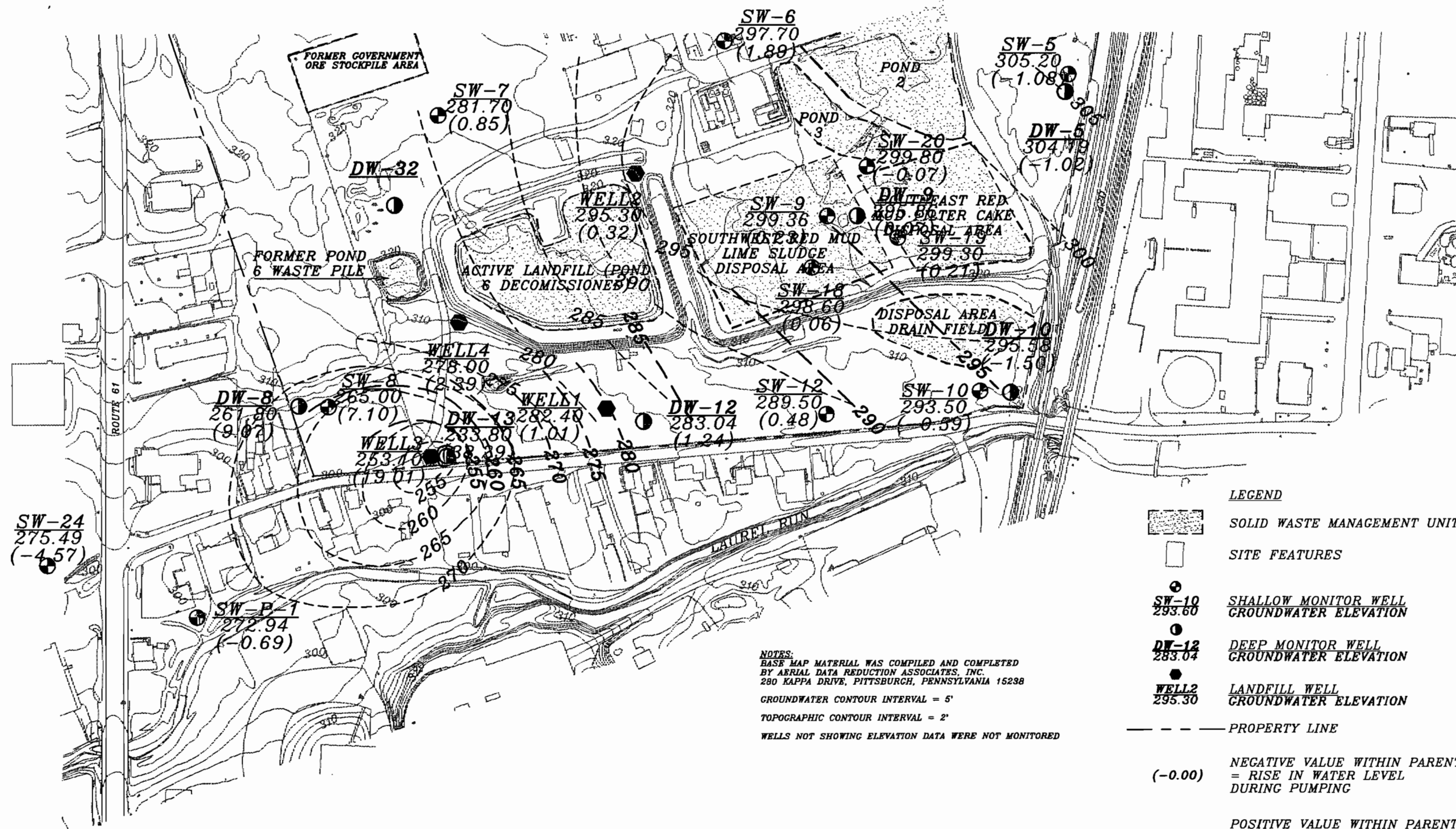


Figure 3-10
Drawdown/Recovery Test Graph
for Pumping Well MW-13B

AR360312





NAMES	DATE	DATUM	MSL.
DRAWN: J.F.M.	May, 1994		
DESIGN:		CONTOUR INTERVAL:	As Noted
PROJ. MGR.: D.V.V.		U.S.G.S. QUAD:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:	1"=200'		

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2 Market Plaza Way
 Mechanicsburg, PA 17055
 (717) 785-6001
 (717) 785-2800 Fax

FIGURE 3-12
 GROUNDWATER ELEVATION MAP
 DW-13 JUNE 21, 1993, MAXIMUM DRAWDOWN
 NGK METALS CORPORATION
 Berks County Pennsylvania

As expected, the nearest observation well to the pumping well, Well 3, exhibited the most drawdown, while respective drawdowns decreased with increasing depth away from the pumping well. Although, the data from well DW-12 suggest that it may be more effectively connected to deep well DW-13 than Well 1, which is slightly closer. Likewise, shallow well SW-8 is closer to DW-13, however, the recorded drawdown is nearly 2 feet less than in deep well DW-8, which is slightly further away. These data indicate that, in general, the hydraulic connection between wells within the deeper aquifer system in this portion of the site is apparently better than the shallow wells with the pumping (deep) well. Groundwater elevation data prior to pumping and at the time of maximum drawdown are shown on Figures 3-11 and 3-12, respectively.

Groundwater recovery responses were recorded immediately following the drawdown test. The water level in the well DW-13 achieved 95% recovery when the data logger was stopped.

3.3.4 DW-27

Deep well DW-27 was pump tested from March 28 to April 1, 1994. The drawdown test lasted approximately 5661 minutes or nearly four days. An initial pumping rate of approximately 90 gpm gradually reduced to 85 gpm over the length of the test. This drop was most likely due to pump inefficiency due to increased head (i.e. deeper water level within the pumping well).

Drawdown (uncorrected) in the pumping well reached nearly 33 feet. Drawdown was also observed in monitor wells SW-22, SW-23, DW-15 and DW-28. The most significant drawdown, more than 7 feet, occurred in well DW-28, which is approximately 160 feet away. Shallow well SW-23 experienced the next highest drawdown of slightly more than 3 feet. This well is about 325 feet from the pumping well. Nearly 2 feet of drawdown was measured in deep well DW-15, which is located roughly 300 feet away. The least amount of water level drop occurred in well SW-22, which is approximately 200 feet from DW-27. Drawdown data indicate a preferred orientation of the area of influence roughly trends west to east paralleling Tuckerton Road. Distance-drawdown data are summarized below in Table 3-5. Water level response graphs are shown on Figures 3-13 and 3-14. Pre-test and maximum drawdown groundwater elevation maps are presented on Figures 3-15 through 3-16.

TABLE 3-5
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-27

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-27 (ft.)</u>
DW-27	32.84	0.33
DW-28	7.36	157
SW-22	0.28	202
DW-15	2.03	300
SW-23	3.06	325

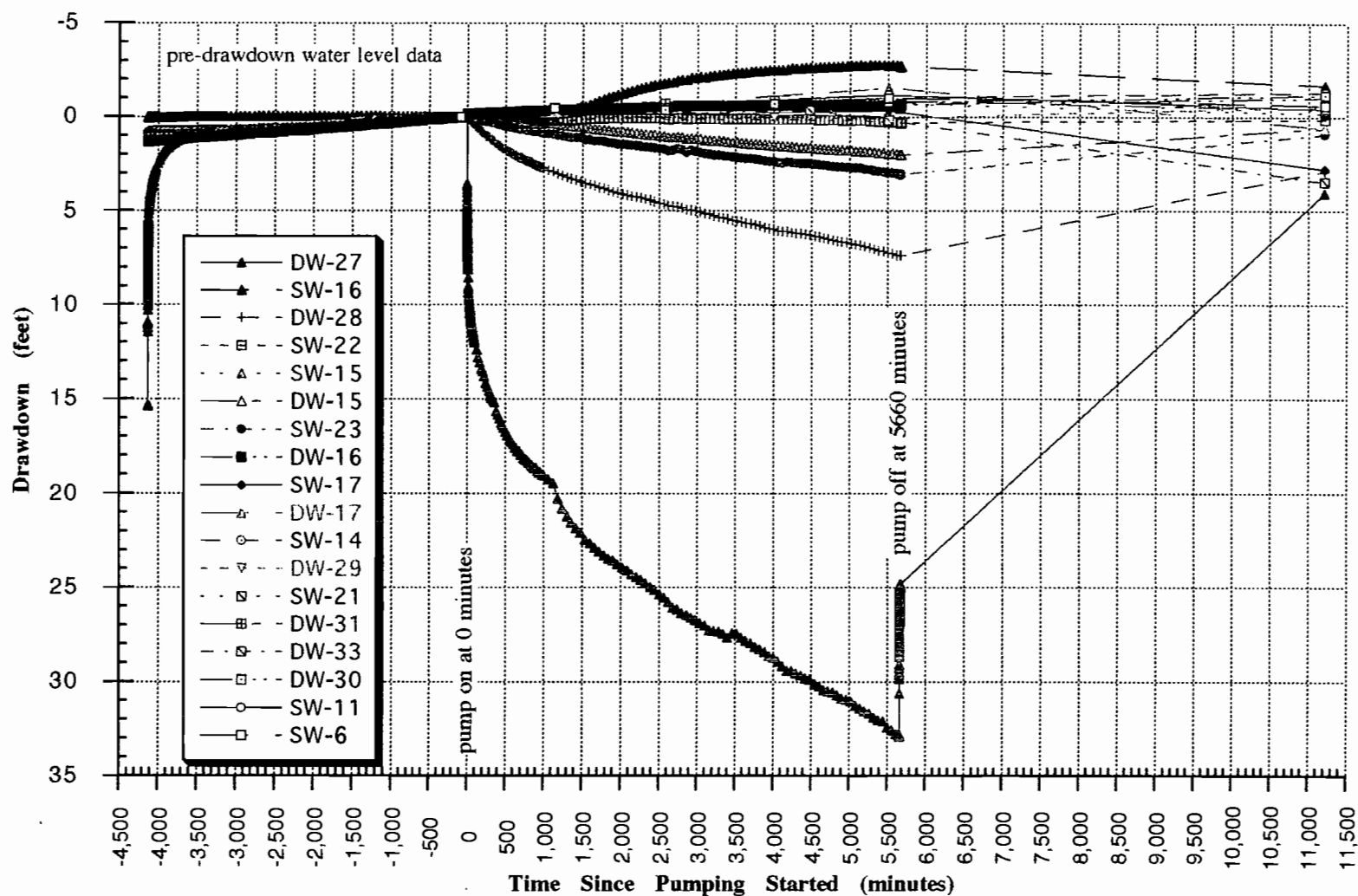


Figure 3-13
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well DW-27

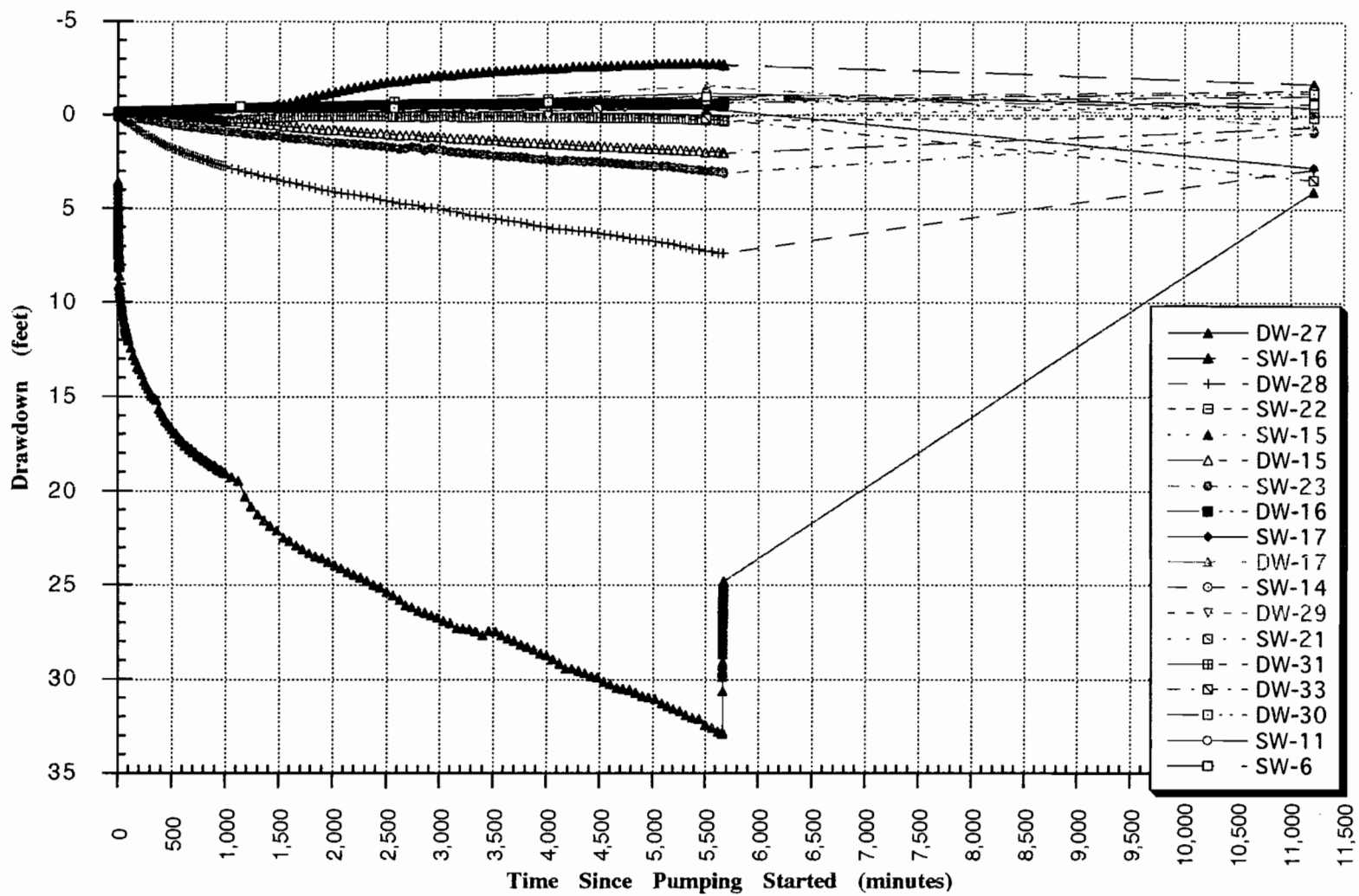
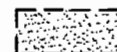


Figure 3-14
Drawdown/Recovery Test Graph
for Pumping Well DW-27

AR360317

LEGEND



SOLID WASTE MANAGEMENT UNIT



SITE FEATURES

●
SW-17
270.55

SHALLOW MONITOR WELL
GROUNDWATER ELEVATION

●
DW-28
273.67

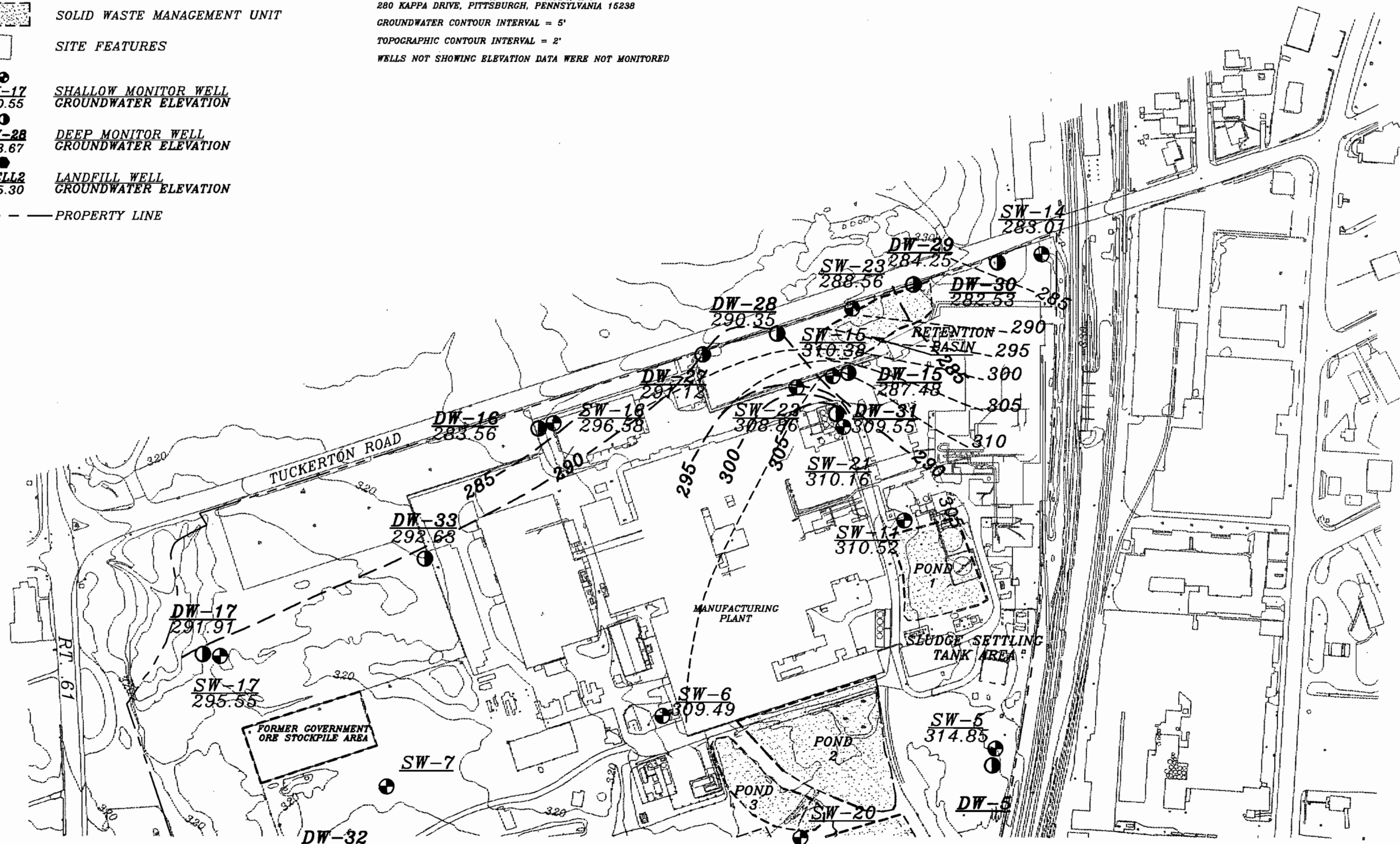
DEEP MONITOR WELL
GROUNDWATER ELEVATION

●
WELL2
295.30

LANDFILL WELL
GROUNDWATER ELEVATION

--- PROPERTY LINE

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
GROUNDWATER CONTOUR INTERVAL = 5'
TOPOGRAPHIC CONTOUR INTERVAL = 2'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NAMES	DATE	DATUM:	M.S.L.
DRAWN: J.F.M.	May, 1994	CONTOUR INTERVAL:	As Noted
DESIGN:		U.S.G.S. QUAD:	Temple
PROJ. MGR.: D.V.V.			
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:	1"=200'		

RUST ENVIRONMENT & INFRASTRUCTURE

2 Market Plaza Way
Mechanicsburg, PA 17055
(717) 786-8001
(717) 786-8220 Fax

CLIENT NO.	
RUST DWG. NO.	
PROJECT NUMBER	35525.300
DATE	
REVISION NUMBER	
SHEET NUMBER	OF

FIGURE 3-15
GROUNDWATER ELEVATION MAP
DW-27 MARCH 28, 1994, PRE-TEST
NGK METALS CORPORATION
Berks County Pennsylvania

CAD FILE NAME: CONTPRETEST27
PLOT DATE:



LEGEND



SOLID WASTE MANAGEMENT UNIT



SITE FEATURES

●
SW-17
295.89

SHALLOW MONITOR WELL
GROUNDWATER ELEVATION

●
DW-28
283.00

DEEP MONITOR WELL
GROUNDWATER ELEVATION

●
WELL2
295.30

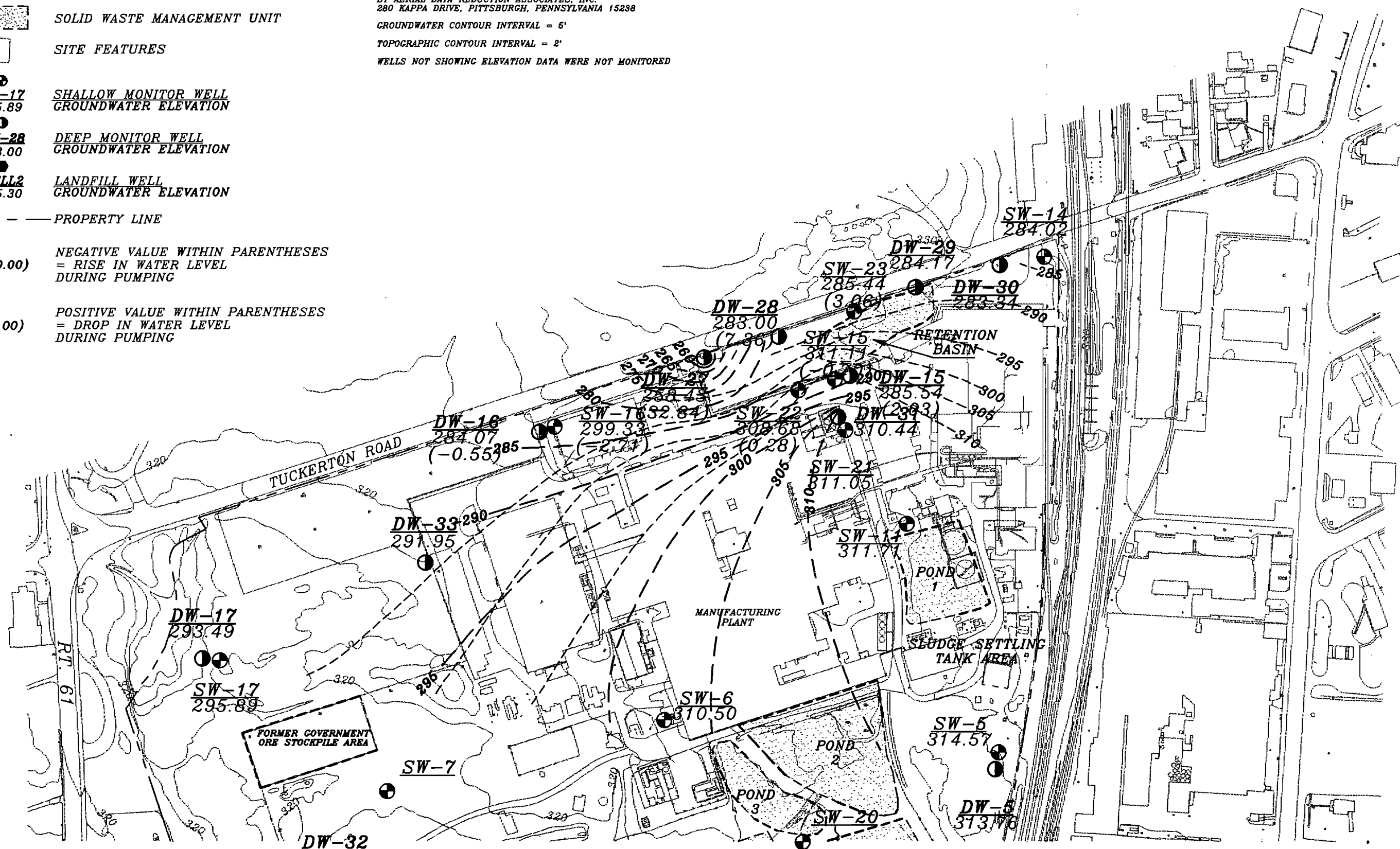
LANDFILL WELL
GROUNDWATER ELEVATION

--- PROPERTY LINE

(-0.00) NEGATIVE VALUE WITHIN PARENTHESES
= RISE IN WATER LEVEL
DURING PUMPING

(0.00) POSITIVE VALUE WITHIN PARENTHESES
= DROP IN WATER LEVEL
DURING PUMPING

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
GROUNDWATER CONTOUR INTERVAL = 5'
TOPOGRAPHIC CONTOUR INTERVAL = 2'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NORTH



NAMES	DATE	DATUM	MSL.
DRAWN: J.F.M.	May, 1994	DATUM:	MSL.
DESIGN:		CONTOUR INTERVAL:	As Noted
PROJ. MGR.: D.V.V.		U.S.G.S. QUAD:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:			
	1"=200'		

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(717) 785-8880 Fax

CLIENT DWG. NO.
RUST DWG. NO.
PROJECT NUMBER 35525.300
DATE
REVISION NUMBER SHEET NUMBER OF
Berkshire County Pennsylvania

FIGURE 3-16
GROUNDWATER ELEVATION MAP
DW-27 APRIL 1, 1994 MAXIMUM DRAWDOWN
NGK METALS CORPORATION

CAD FILE NAME: CONTMAXDB27

AR360319



Immediately following pump shut-off water level responses were recorded during the recovery period. Four days after the pump was shut off, well DW-27 achieved approximately 90% recovery.

3.3.5 DW-28

Drawdown/recovery testing of well DW-28 was performed from July 30 to August 3, 1993. The drawdown test lasted approximately 4025 minutes or nearly three days. An initial pumping rate of 8 gpm eventually dropped to approximately 4 gpm after about 1090 minutes. This decrease in pumping rate coincided with a water level decline to the pump intake. The pump test continued for roughly two more days at a sustained pumping rate of 4 gpm. Water level response graphs are presented on Figures 3-17 and 3-18.

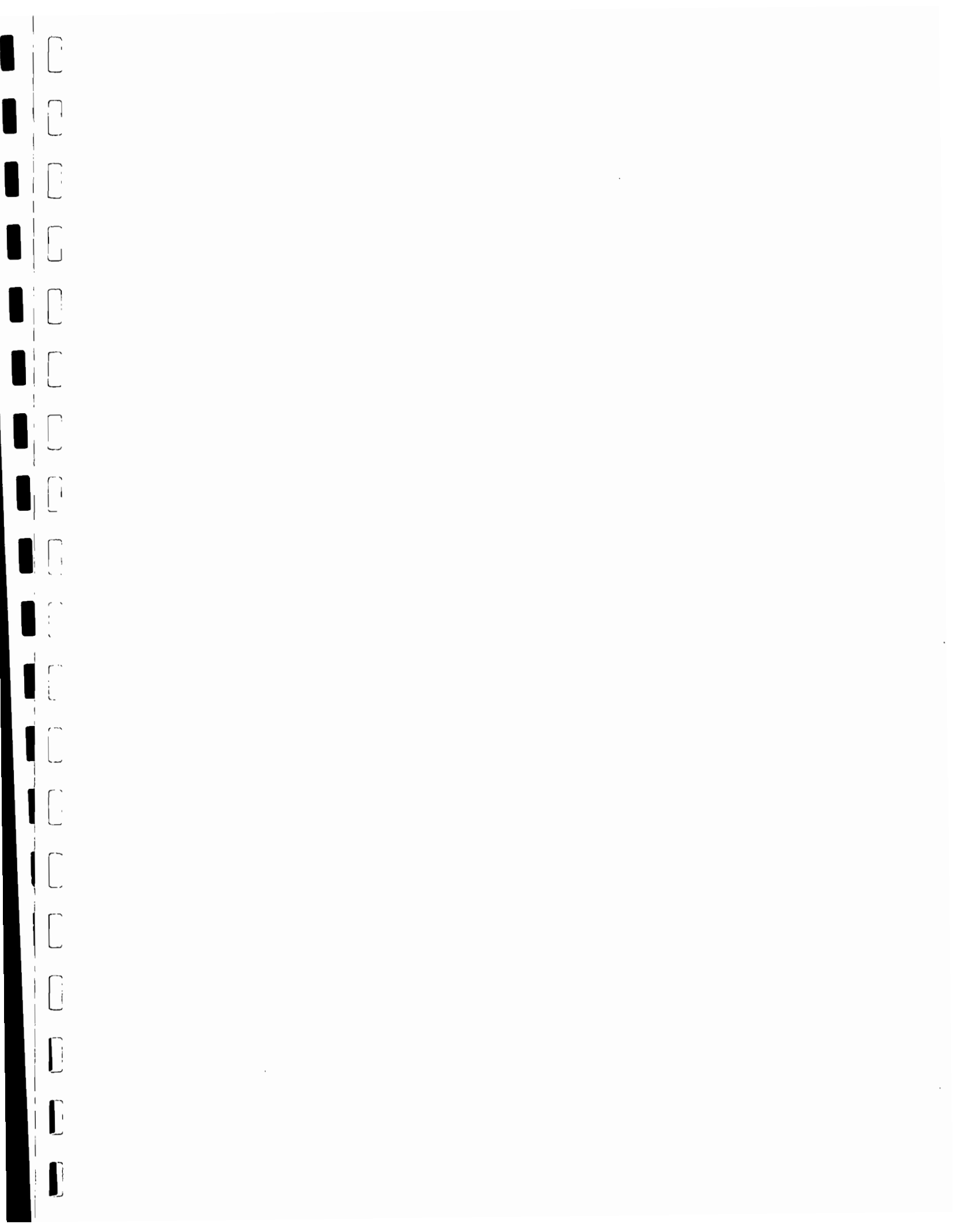
The pumping well reached a maximum drawdown of approximately 40 feet. This maximum drawdown is uncorrected due to impacts of the step-drawdown test to the pre-test water level trend. It is anticipated that corrections to the drawdown in the pumping well would be minor, and, therefore, represent an insignificant proportion of the total recorded drawdown.

Drawdown in well SW-21, about 233 feet from DW-28, was approximately 7 feet. Seven feet was the maximum drawdown observed in all monitored wells. Recorded drawdown in wells SW-23 and DW-31 were 0.91 and 0.80 feet, respectively. Shallow well SW-23 is about 162 feet from DW-28, while deep well DW-31 is about 203 feet away. Distance-drawdown data are summarized below.

TABLE 3-6
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-28

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-28 (ft.)</u>
DW-28	40.40	0.33
SW-23	0.91	162
DW-31	0.80	203
SW-21	7.06	233

The sustained pumping of well DW-28 appears to have little impact on depressing the water level surface for both the shallow and deep aquifer systems over an extended area. There is, however, an apparent hydraulic connection between the pumping well and SW-21. It is possible that these two wells are connected to each other within the bulk aquifer by way of a conduit (i.e. solution channel). A void was encountered in well SW-21 from 26 to 30 feet, and in well DW-28 at 63 to 74 feet. Pre-test and maximum drawdown groundwater elevations are shown on Figures 3-19 and 3-20, respectively.



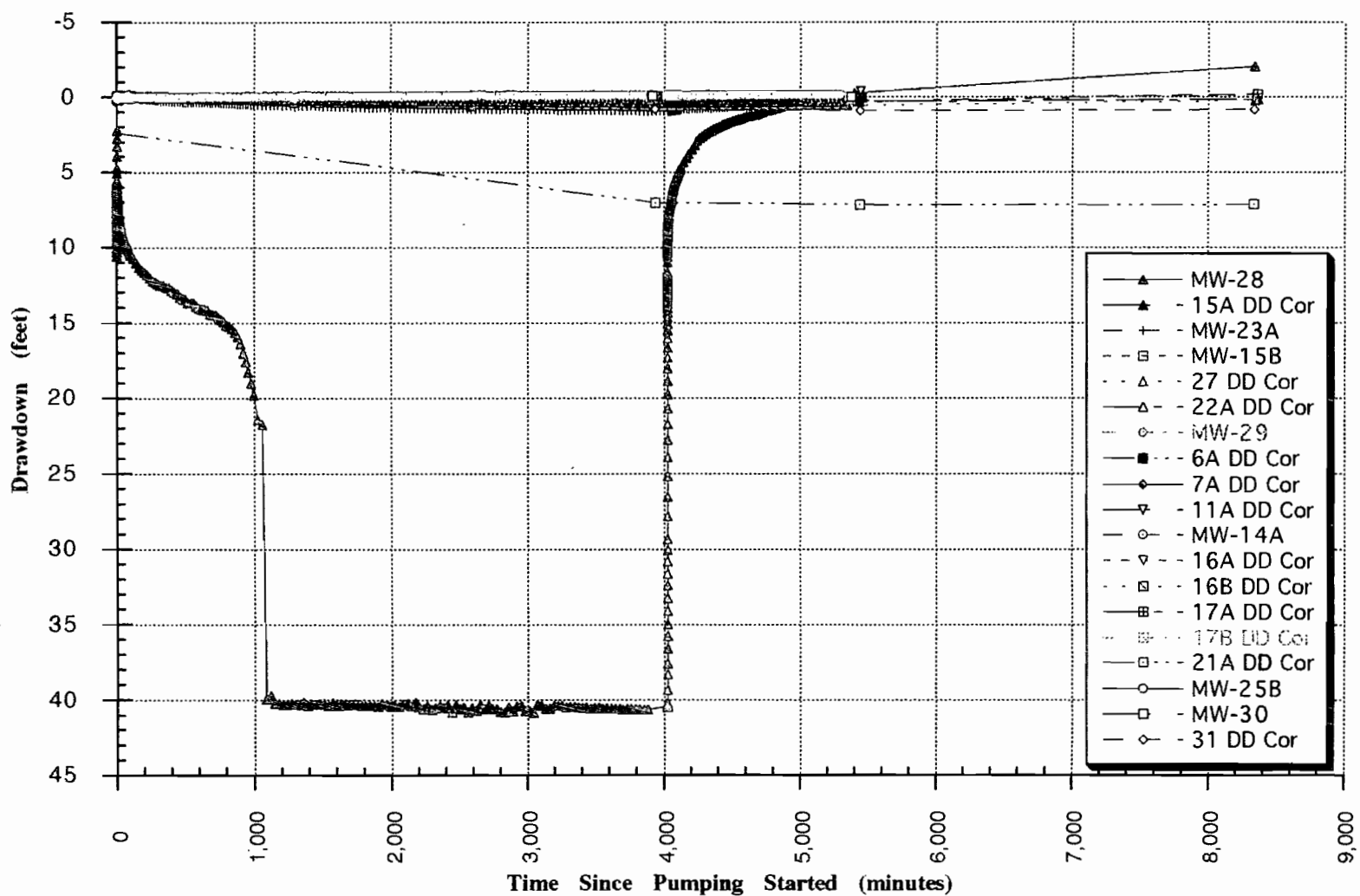


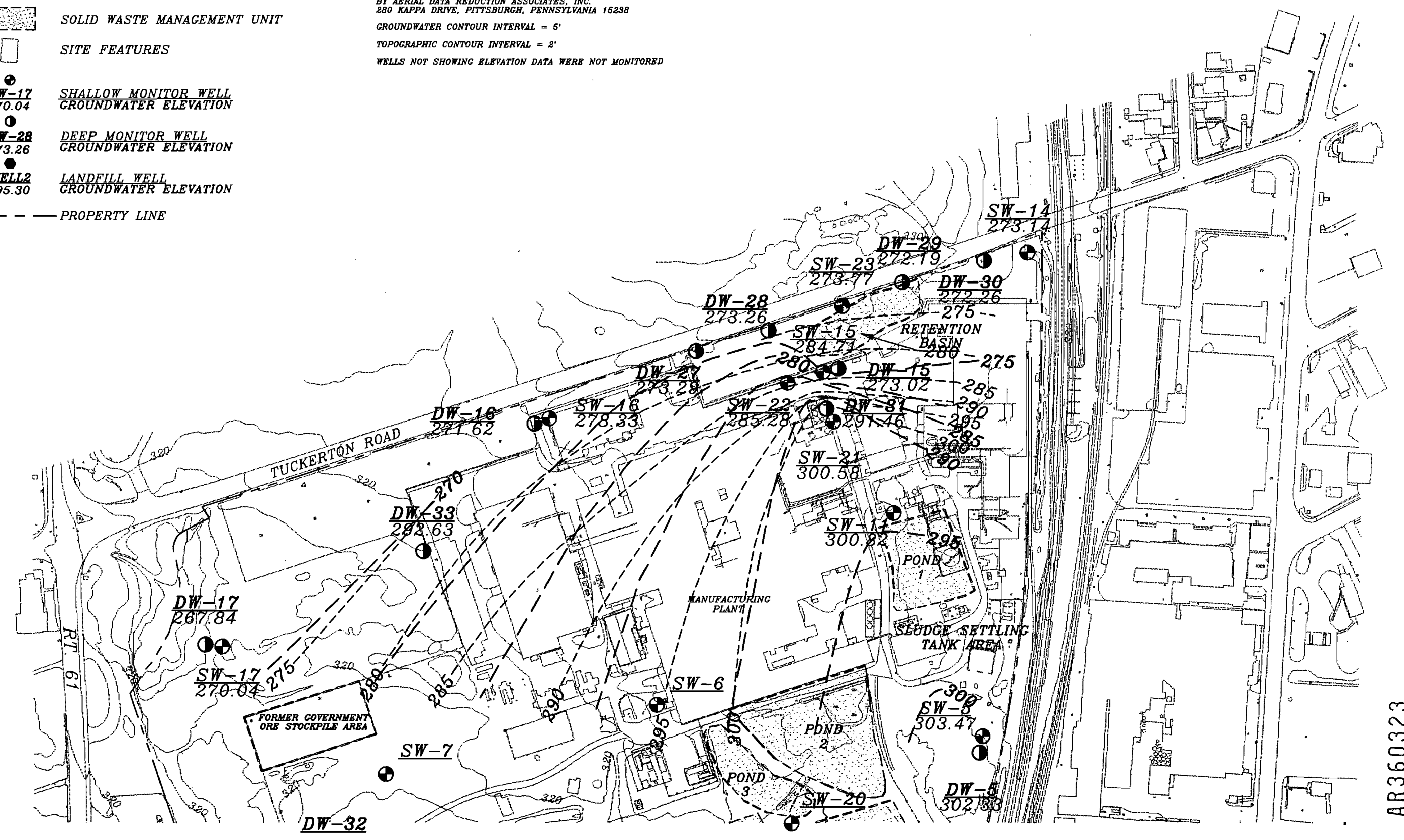
Figure 3-18
Drawdown/Recovery Test Graph
for Pumping Well MW-28

AR360322

LEGEND

- SOLID WASTE MANAGEMENT UNIT
- SITE FEATURES
- SW-17 SHALLOW MONITOR WELL
270.04 GROUNDWATER ELEVATION
- DW-28 DEEP MONITOR WELL
273.26 GROUNDWATER ELEVATION
- WELL2 LANDFILL WELL
295.30 GROUNDWATER ELEVATION
- PROPERTY LINE

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
GROUNDWATER CONTOUR INTERVAL = 5'
TOPOGRAPHIC CONTOUR INTERVAL = 2'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NORTH

NAMES	DATE	DATUM	MSL.
DRAWN: J.F.M.	May, 1994		
DESIGN: J.F.M.		CONTOUR INTERVAL: As Noted	
PROJ. MGR.: D.V.V.		U.S.G.S. QUAD: Temple	
PROJ. ENG.: C.M.S.			
CHECKED: J.P.P.			
SCALE: 1"=200'			

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CLIENT DWG. NO.	FIGURE 3-19
RUST DWG. NO.	GROUNDWATER ELEVATION MAP
PROJECT NUMBER 35525.300	DW-28 JULY 28, 1993 PRE-TEST
DATE	NGK METALS CORPORATION
REVISION NUMBER	BERKS County Pennsylvania
SHEET NUMBER OF	

CAD FILE NAME: CONTPRETEST28

AR360323



A groundwater recovery test was performed immediately after the pump was shut off. The water level in well DW-28 achieved full recovery by the next day. The water level response plot of well DW-28 (see Figure 3-13) extends beyond zero drawdown indicating that the water level rose above the pre-test static water level.

3.3.6 DW-29

Deep well DW-29 was drawdown tested from July 23 to July 26, 1993 at an average pumping rate of approximately 87 gpm. The pumping rate was established initially at about 115 gpm, and eventually decreased to approximately 74 gpm. During the test the water level in the pumping well gradually dropped until it reached the pump intake. The well sustained a yield of 74 gpm despite the water reaching the pump intake. The well was pumped for a total of 3483 minutes, at which time the recovery test began. Total corrected drawdown in well DW-29 was slightly more than 41 feet. Water level responses to pumping well DW-29 are shown on Figures 3-21 and 3-22.

Drawdowns (corrected) of one or more feet were recorded in five of the monitored observation wells. These wells along with their respective corrected drawdowns and distances from the pumping well are summarized below.

TABLE 3-7
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-29

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-29(ft.)</u>
DW-29	41.28	0.42
SW-23	2.95	134
DW-30	3.66	176
DW-15	6.06	224
SW-14	2.58	270
DW-28	1.57	296

The water level in downgradient deep well DW-30 responded to pumping of DW-29 by dropping almost 4 feet. DW-30 is the nearest deep observation well to the pumping well. Upgradient well DW-15, which is the next closest deep well, showed the most significant dropping water level recorded at nearly 6 feet. The resultant drawdown in DW-15 indicates that the well is effectively connected to well DW-29 within the bulk aquifer. This connection is apparently along strike (bearing) of the underlying bedrock, which is reportedly N65°E in the area of the NGK site. This direction is roughly parallel to a line drawn through DW-15 and DW-29. Figure 3-23 shows pre-test groundwater elevation data and maximum groundwater elevation data are presented on Figure 3-24.

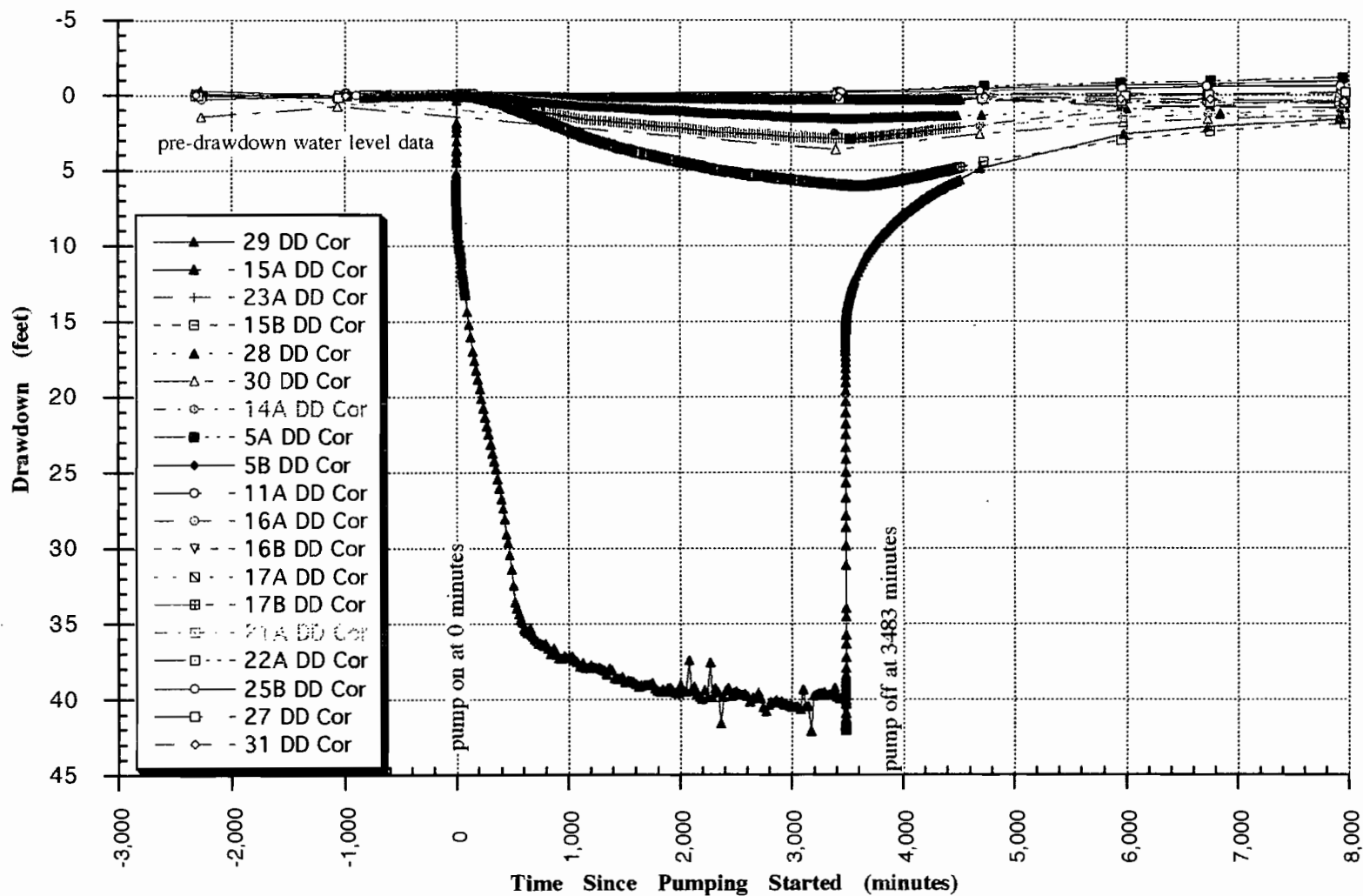


Figure 3-21
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well MW-29

AR360326

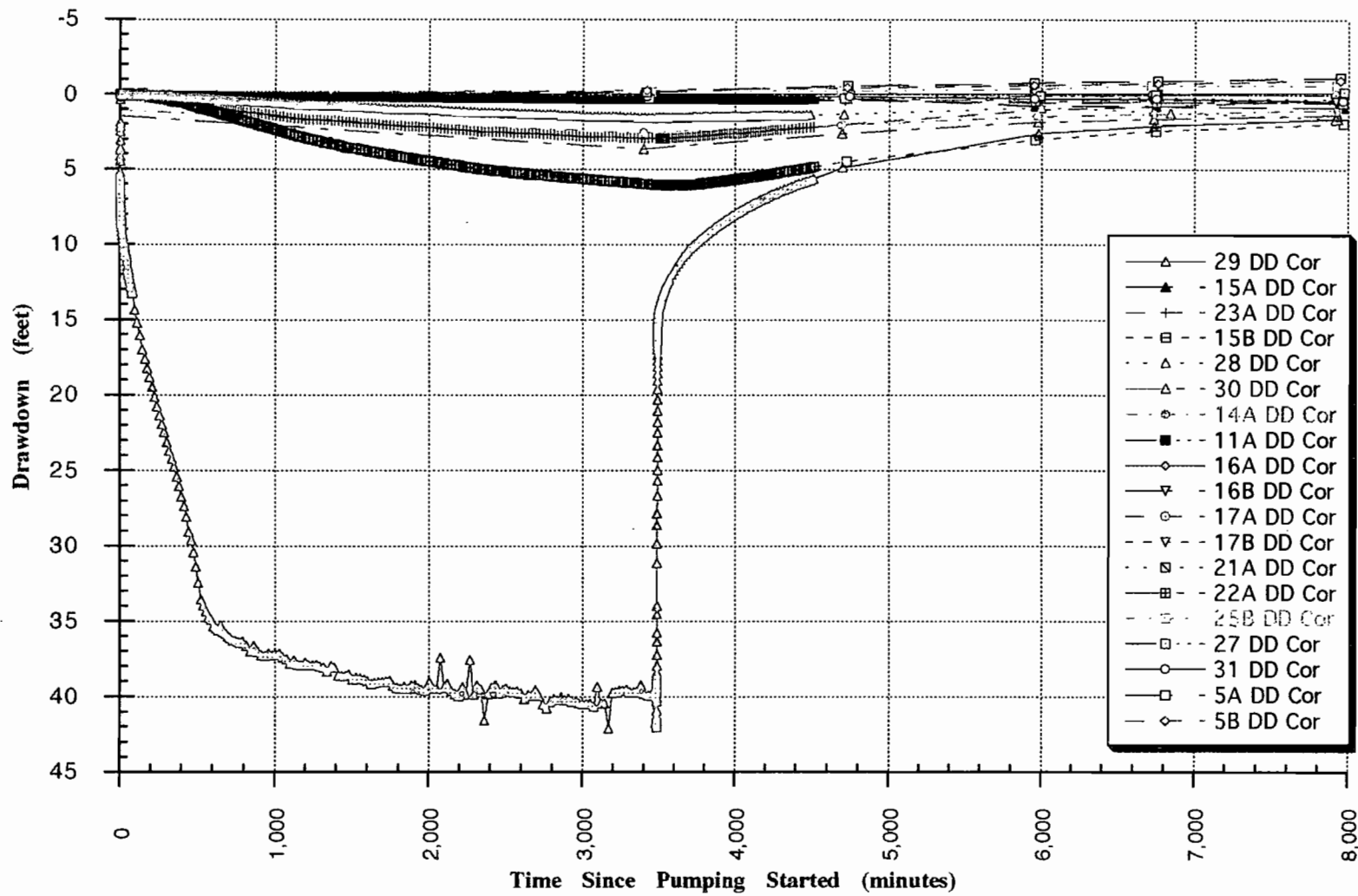


Figure 3-22
Drawdown/Recovery Test Graph
for Pumping Well MW-29

AR360327

LEGEND



SOLID WASTE MANAGEMENT UNIT



SITE FEATURES

SW-17
270.72

SHALLOW MONITOR WELL
GROUNDWATER ELEVATION

DW-28
275.83

DEEP MONITOR WELL
GROUNDWATER ELEVATION

WELL2
295.30

LANDFILL WELL
GROUNDWATER ELEVATION

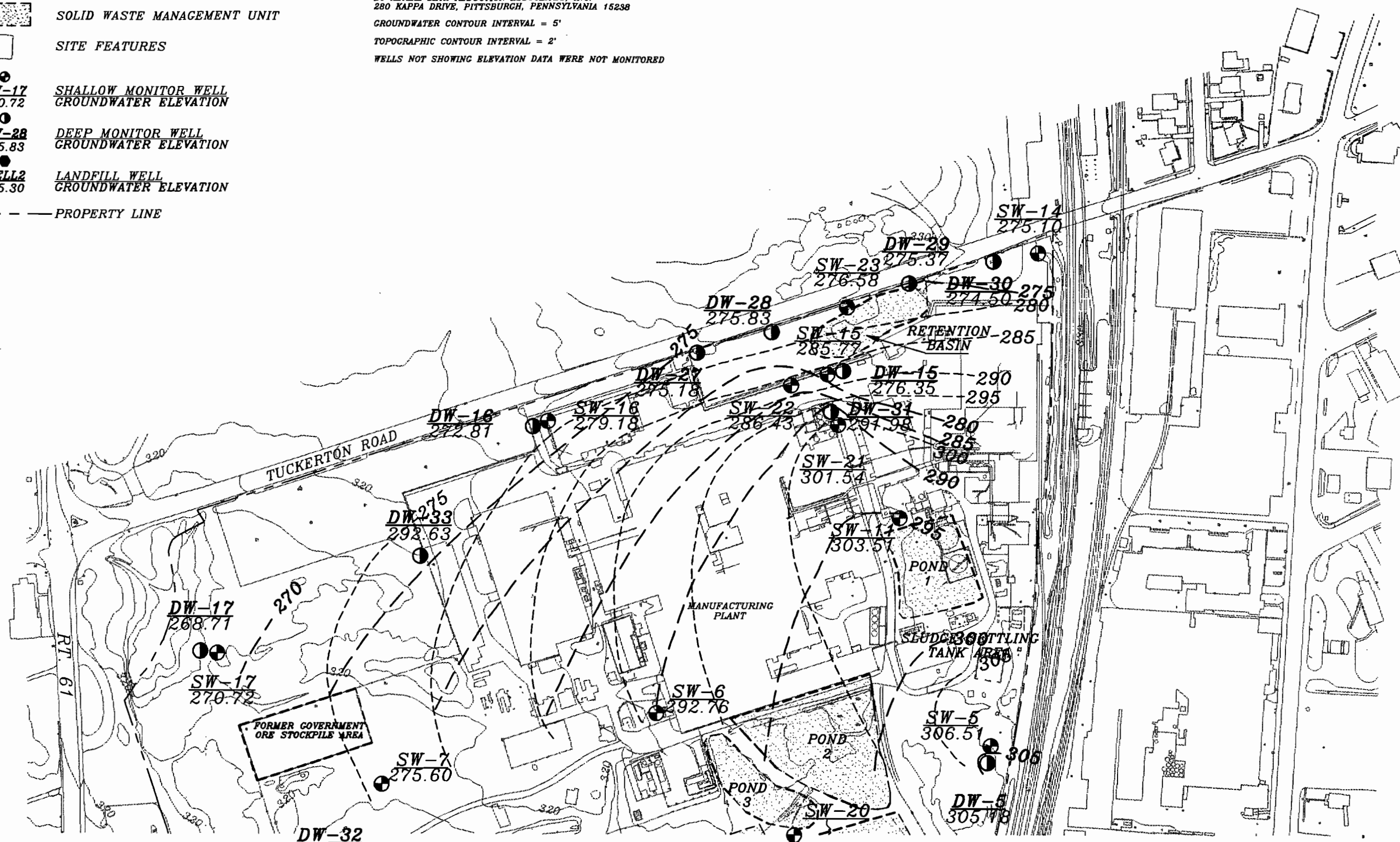
PROPERTY LINE

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238

GROUNDWATER CONTOUR INTERVAL = 5'

TOPOGRAPHIC CONTOUR INTERVAL = 2'

WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NORTH



NAMES	DATE	DATUM	M.S.L.
DRAWN: J.F.M.	May, 1994		
DESIGN:	As Noted	CONTOUR INTERVAL:	
PROJ. MGR.: D.W.V.		U.S.G.S. QUAD.:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:	1"=200'		

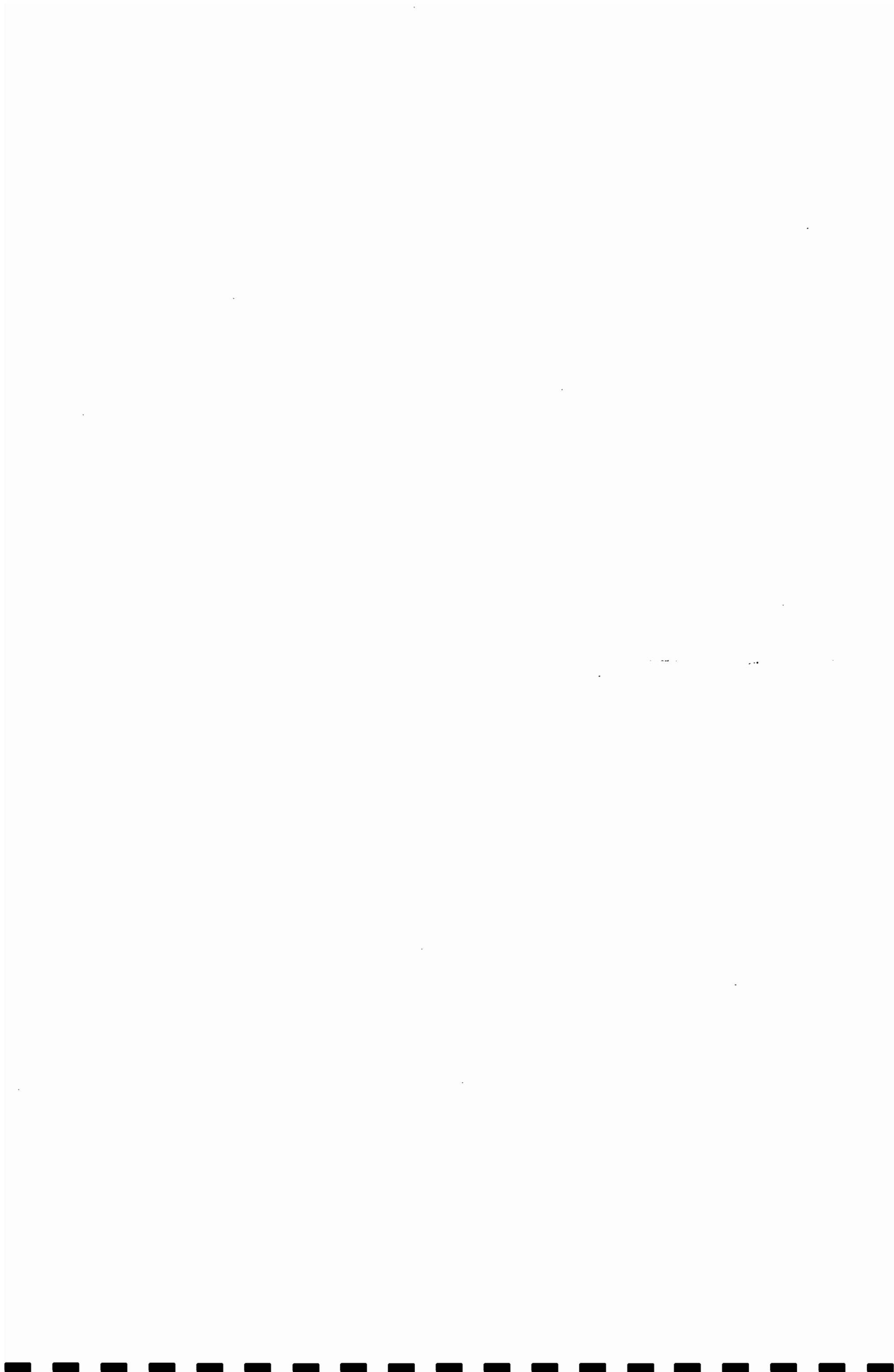
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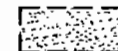
FIGURE 3-23
GROUNDWATER ELEVATION MAP
DW-29 JULY 21, 1993 PRE-TEST
NGK METALS CORPORATION
Berks County Pennsylvania

CAD FILE NAME: CONTPRETEST29

AR360328



LEGEND



SOLID WASTE MANAGEMENT UNIT



SITE FEATURES

SW-17
270.55

SHALLOW MONITOR WELL
GROUNDWATER ELEVATION

DW-28
273.67

DEEP MONITOR WELL
GROUNDWATER ELEVATION

WELL2
295.30

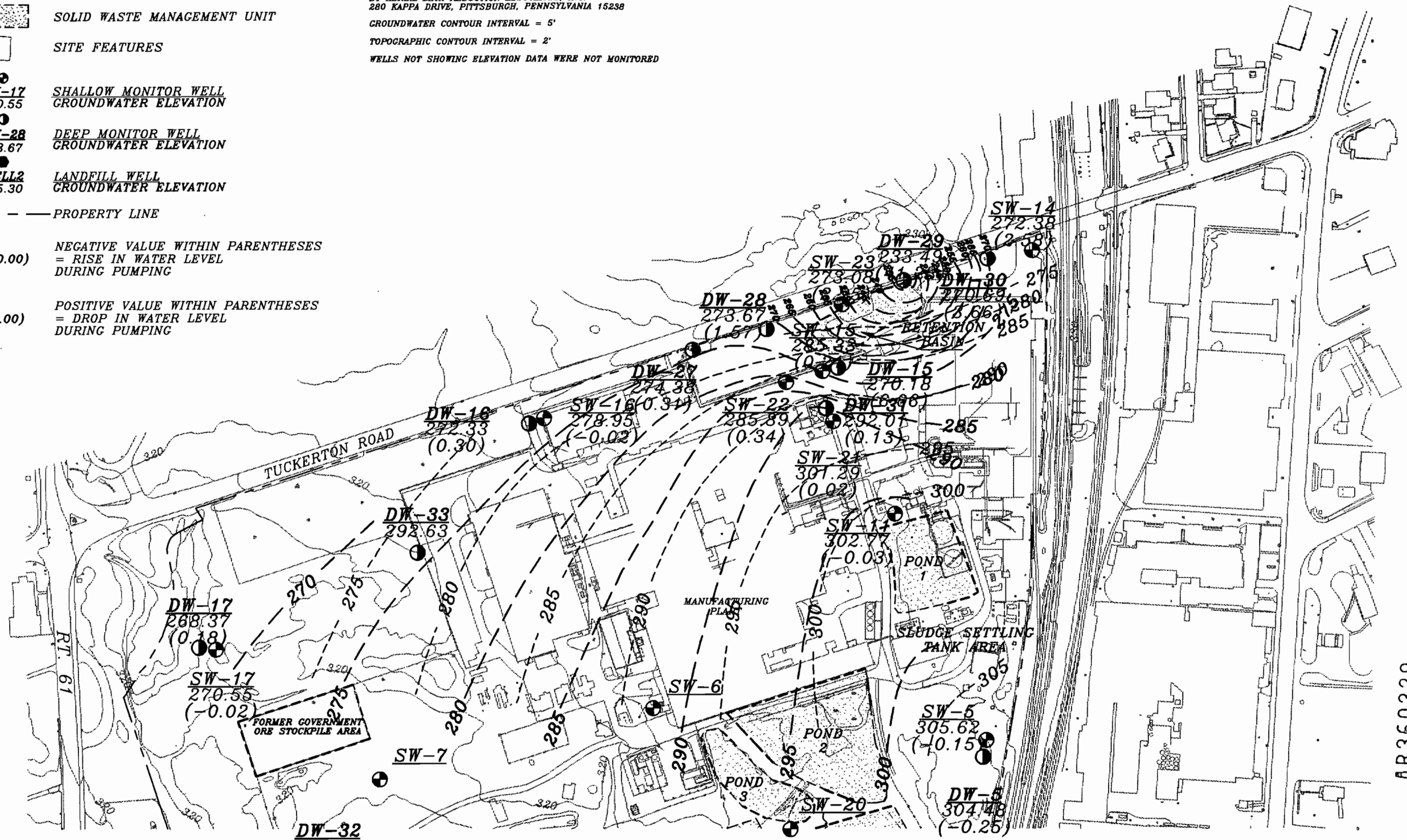
LANDFILL WELL
GROUNDWATER ELEVATION

PROPERTY LINE

(-0.00) NEGATIVE VALUE WITHIN PARENTHESES
= RISE IN WATER LEVEL
DURING PUMPING

(0.00) POSITIVE VALUE WITHIN PARENTHESES
= DROP IN WATER LEVEL
DURING PUMPING

NOTES:
BASE MAP MATERIAL WAS COMPILED AND COMPLETED
BY AERIAL DATA REDUCTION ASSOCIATES, INC.
280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
GROUNDWATER CONTOUR INTERVAL = 5'
TOPOGRAPHIC CONTOUR INTERVAL = 2'
WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



NORTH



NAMES	DATE
DRAWN: J.F.M.	May, 1994
DESIGN:	DATUM: M.S.L.
PROJ. MGR.: D.W.V.	CONTOUR INTERVAL: As Noted
PROJ. ENG.: C.M.S.	U.S.G.S. QUAD.: Temple
CHECKED: J.J.P.	
SCALE:	
	1"=200'

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(717) 795-8280 Fax

CLIENT	DWG. NO.
RUST	DWG. NO.
PROJECT NUMBER	35323.300
DATE	26 JULY 1993
REVISION	SHEET NUMBER
NUMBER	OF

FIGURE 3-24
GROUNDWATER ELEVATION MAP
DW-29 JULY 26, 1993 MAXIMUM DRAWDOWN
NGK METALS CORPORATION
Berkshire County Pennsylvania

CAD FILE NAME: CONTMAXDD29

AR360329



After completion of the drawdown test, water level responses during the recovery period were recorded. The water level in pumping well DW-29 reached approximately 95% recovery prior to stoppage of the test. No precipitation events were reported during the recovery period that may have affected the water level responses.

3.3.7 DW-32

Drawdown/recovery testing was performed on well DW-32 from March 29 to April 2, 1994. The well was pumped, initially at a rate of 10 gpm, for 5776 minutes or approximately four days. The pumping rate dropped slightly to approximately 9 gpm during the test most likely due to pump inefficiency affected by an increase in hydraulic head (i.e. lower water level).

A total (uncorrected) drawdown of approximately 63 feet was achieved in well DW-32. The pumping water level appeared to reach equilibrium at a rate of 9 gpm. Well SW-7 exhibited the most drawdown in monitored observation wells. Here, more than two feet of drawdown occurred. The well is located approximately 200 feet from the pumping well. Drawdowns in monitor wells DW-13, SW-8, Well 2, Well 3, and Well 4 all were approximately 0.7 feet and may have been due to pumping. The water level response curves shown on Figures 3-25 and 3-26 indicate that well SW-7 mimics the drawdown curve for DW-32. Well 4 was impacted due to pumping because the rising water level leveled at the time pumping began. To a lesser extent, the water level in DW-8 showed a similar but delayed response. The responses wells DW-8 and Well 4 indicate that they both were impacted by pumping and naturally declining water levels.

The area of influence created by pumping well DW-32 appears to extend from at least shallow well SW-7 to Well 4 and towards deep well DW-8. Pre-test and maximum drawdown maps are shown on Figures 3-27 and 3-28. Distance-drawdown data are summarized below.

TABLE 3-8
DRAWDOWN AND DISTANCE SUMMARY
PUMPING WELL DW-32

<u>WELL</u>	<u>DRAWDOWN(ft.)</u>	<u>DISTANCE FROM DW-32 (ft.)</u>
DW-32	63.19	0.33
SW-7	2.28	200
Well 4	0.77	263
SW-8	0.62	420
Well 2	0.76	478
DW-13	0.71	500
Well 3	0.70	502

Water level recovery data were recorded immediately following pump shut off. The water level in well DW-32 reached approximately 93% recovery when data logging was terminated.

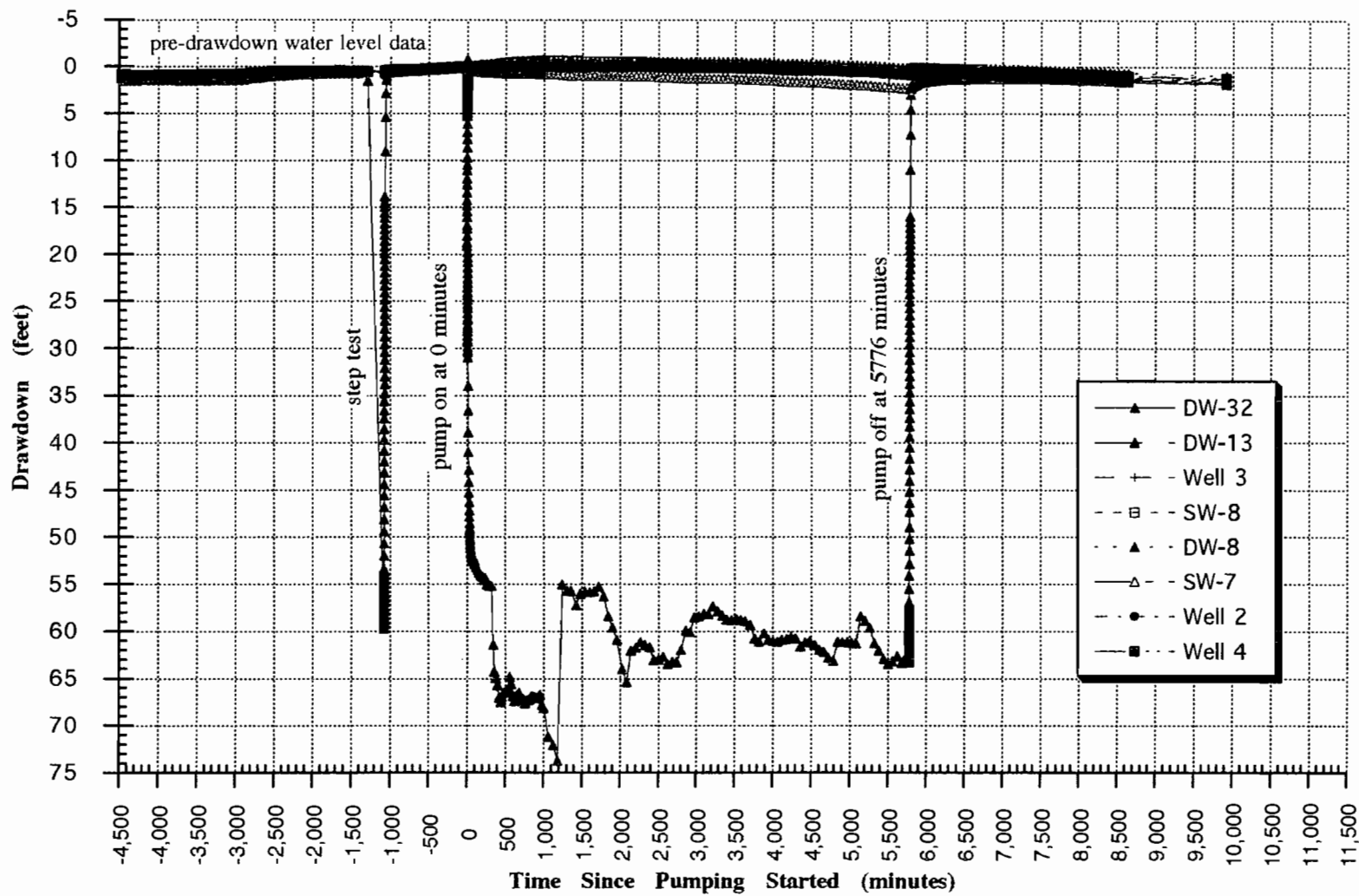


Figure 3-25
Pre-Test/Drawdown/Recovery Test Graph
for Pumping Well DW-32

AR360331

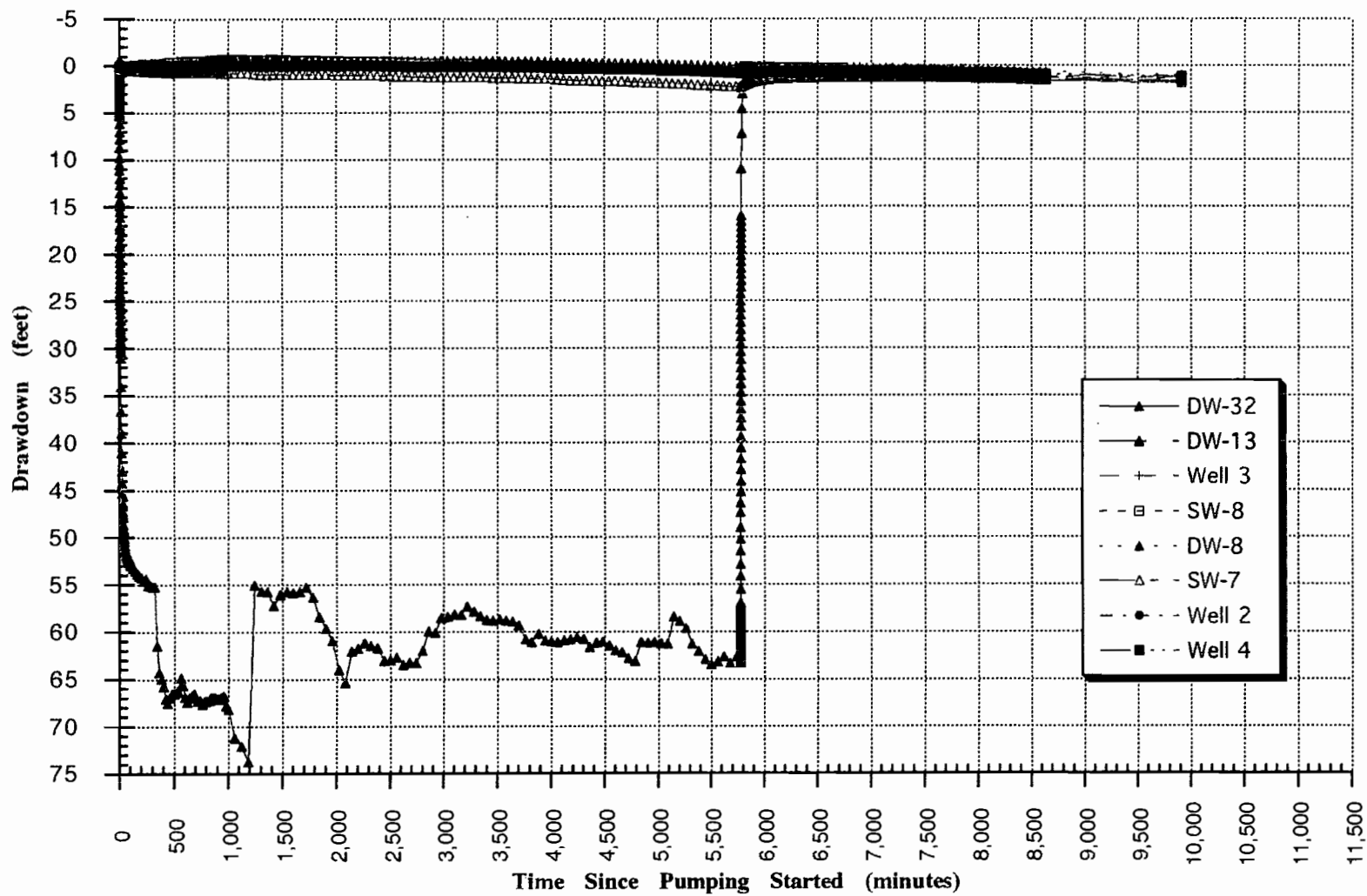
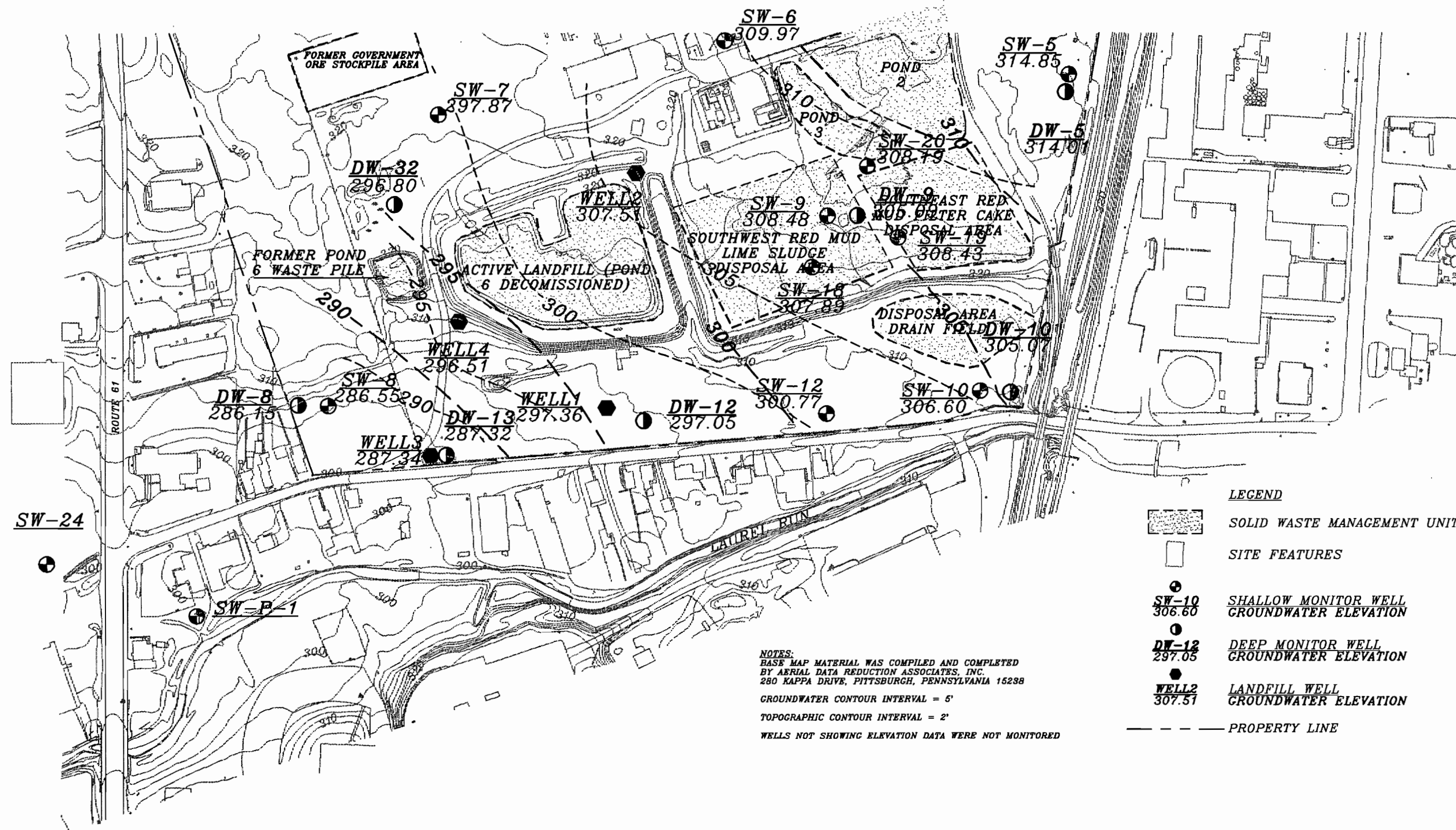


Figure 3-26
Drawdown/ Recovery Test Graph
for Pumping Well DW-32

AR360332



NOTES:
 BASE MAP MATERIAL WAS COMPILED AND COMPLETED
 BY AERIAL DATA REDUCTION ASSOCIATES, INC.
 280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15238
 GROUNDWATER CONTOUR INTERVAL = 5'
 TOPOGRAPHIC CONTOUR INTERVAL = 2'
 WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED

- LEGEND**
- SOLID WASTE MANAGEMENT UNIT
 - SITE FEATURES
 - SHALLOW MONITOR WELL
SW-10 306.60 GROUNDWATER ELEVATION
 - DEEP MONITOR WELL
DW-12 297.05 GROUNDWATER ELEVATION
 - LANDFILL WELL
WELL2 307.51 GROUNDWATER ELEVATION
 - PROPERTY LINE

NORTH

NAMES		DATE	DATUM	M.S.L.
DRAWN: J.F.M.		May, 1994		
DESIGN: J.F.M.			CONTOUR INTERVAL: As Noted	
PROJ. MGR.: D.V.V.			U.S.G.S. QUAD.: Temple	
PROJ. ENG.: C.M.S.				
CHECKED: J.J.P.				
SCALE: 1"=200'				

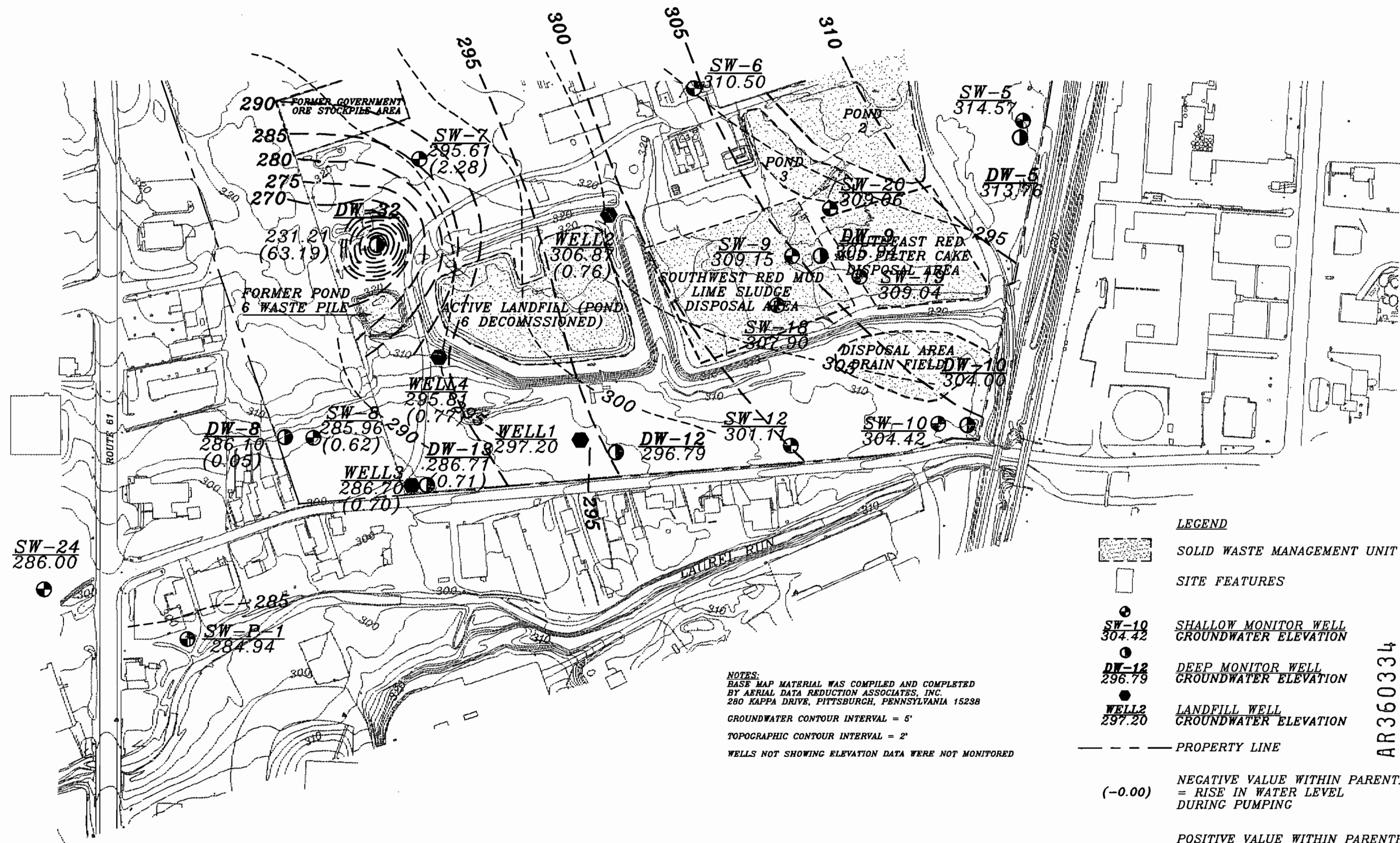
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2 Market Plaza Way
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FIGURE 3-27
GROUNDWATER ELEVATION MAP
 DW-32 MARCH 29, 1994, PRE-TEST
 NGK METALS CORPORATION

AR360333





NAMES	DATE	DATUM	M.S.L.
DRAWN: J.F.M.	May, 1994		
DESIGN:		CONTOUR INTERVAL:	As Noted
PROJ. MGR.: D.V.V.		U.S.G.S. QUAD:	Temple
PROJ. ENG.: C.M.S.			
CHECKED: J.J.P.			
SCALE:			
	1"=200'		

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 (717) 796-8200 Fax

FIGURE 3-28
GROUNDWATER ELEVATION MAP
 DW-32 APRIL 2, 1994, MAXIMUM DRAWDOWN
 NGK METALS CORPORATION

AR360334



4.0 GROUNDWATER CHEMISTRY

4.1 INTRODUCTION

During each of the respective drawdown tests, groundwater samples were collected on regular intervals and submitted to Lancaster Laboratories for analysis. Analytical testing was conducted on each groundwater sample to provide well-specific chemistry data. These data were analyzed and evaluated to establish trends in chemical concentrations as a function of increased pumping time. The samples were analyzed for the following site-specific and general parameters:

TABLE 4-1
ANALYTICAL PARAMETERS FOR PUMP TESTS

Site-Specific Parameters

Beryllium (total)
Cadmium (total)
Chromium (total)
Copper (total)
Fluoride
Purgeable Halocarbons
Purgeable Aromatics

General Parameters

Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Total Hardness
Iron (total)
Nitrate-Nitrogen*
Sulfate*

Field Parameters

Temperature
Specific Conductivity
pH

* Nitrate-Nitrogen and Sulfate were analyzed only for wells DW-27 and DW-32

In addition, new deep wells DW-27, DW-30, DW-32 and DW-33 were sampled to characterize groundwater quality in the area of these respective wells. Groundwater samples were analyzed for those parameters summarized above along with Priority Pollutant Metals, chloride, sulfate and nitrate-nitrogen. These data are presented in Table 4-2. These parameters were selected based on water quality characteristics needed to conduct pilot scale tests to determine the effectiveness of a proposed water treatment system. New deep well DW-31 was not sampled due to low well yield.

4.2 ANALYTICAL RESULTS

Groundwater samples were collected during each of the individual drawdown tests on a daily basis, whenever possible. The total number of samples per well depended on the duration of each drawdown test.

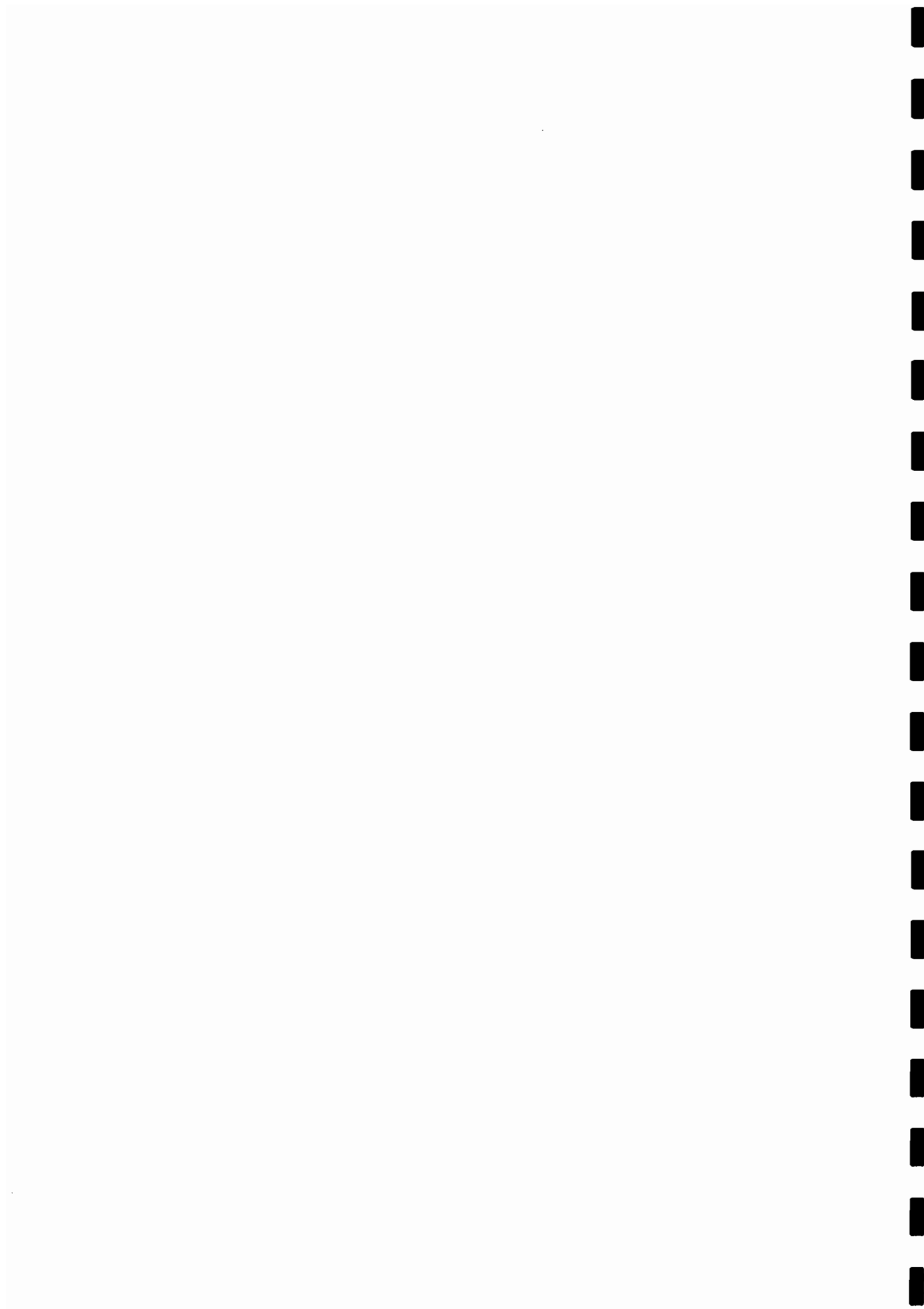


TABLE 4-2
NGK METALS NEW WELLS

WELL	DW-27	DW-30	DW-32	DW-33
LAB PARAMETER				
(mg/l)				
TSS	47	10	296	109
TDS	990	800	840	410
Total Hardness	657	402	314	273
Chloride	110	45	NA	NA
Fluoride	4.8	9.4	15	2.1
Sulfate	310	290	NA	NA
Nitrate-Nitrogen	19	8.4	NA	NA
LAB PARAMETER				
(mg/l)				
Arsenic	0.0028	<0.0020	NA	NA
Mercury	<0.00020	<0.00020	NA	NA
Selenium	<0.0020	<0.0020	NA	NA
Thallium	<0.30	<0.30	NA	NA
Antimony	<0.20	<0.20	NA	NA
Beryllium	0.100	<0.010	0.025	<0.010
Cadmium	<0.010	<0.010	<0.010	<0.010
Chromium	0.404	<0.050	0.051	0.048
Copper	0.088	<0.020	0.05	<0.025
Iron	3.40	1.21	31.10	7.47
Lead	<0.10	<0.10	NA	NA
Nickel	<0.050	<0.050	NA	NA
Silver	<0.020	<0.020	NA	NA
Zinc	<0.040	<0.040	NA	NA
LAB PARAMETER				
(µg/l)				
1,2-DCE (cis/trans)	<1	3	1	<1
1,1-DCE	<1	<1	29	5
1,1-DCA	<1	<1	30	1
1,1,1-TCA	7	2	46	2
TCE	1	<1	5	2
PCE	<1	<1	<1	18
FIELD				
PARAMETER				
Temperature (°C)	NA	14.7	NA	NA
Specific Conductivity (mU/cm)	1.56	0.985	0.840	0.460
pH (Standard units)	NA	7.20	7.12	7.17
Turbidity (NTU)	<200	25.1	NA	NA

NA=Not Available/Analyzed



TABLE 4-3
NGK METALS PUMP TESTS
CHEMICAL DATA SUMMARY

WELL	MW-8A				MW-12B					
SAMPLE NO.	MW-8A-1	MW-8A-2	MW-8A-3	MW-8A-4	MW-12B-1	MW-12B-2	MW-12B-3	MW-12B-1 (1)	MW-12B-2 (1)	MW-12B-3 (1)
LAB PARAMETER (mg/l)										
TSS	45	24	<7	<7	6400	201	134	3020	280	37
TDS	690	550	550	580	910	740	730	870	740	760
Total Hardness	137	123	125	125	281	62	64	161	64	64
Fluoride	23.6	18.6	18.8	19.5	81.0	45.1	47.2	65.3	43.4	45.7
Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate-Nitrogen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LAB PARAMETER (mg/l)										
Beryllium	0.019	0.015	0.014	0.014	0.334	0.022	0.023	0.230	0.036	0.024
Cadmium	<0.005	<0.010	<0.010	<0.010	0.076	<0.010	<0.010	0.022	<0.010	<0.010
Chromium	0.353	0.349	0.331	0.326	0.610	0.235	0.236	0.527	0.295	0.269
Copper	<0.025	<0.02	<0.02	<0.020	0.510	<0.020	0.028	0.546	0.107	0.064
Iron	3.33	1.24	0.15	0.11	518	7.22	8.74	401	20.5	4.18
LAB PARAMETER (µg/l)										
Methylene Chloride	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-DCE (cis/trans)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-DCE	19	10	10	9	<1	1	2	<1	4	3
1,1-DCA	7	4	5	4	<1	2	2	2	2	2
1,1,1-TCA	65	35	34	33	<1	9	12	5	16	15
1,1,2-TCA	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TCE	2	2	1	1	3	2	2	3	2	2
PCE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
FIELD PARAMETER										
Temperature (°C)	13.3	13.9	13.3	14.4	14.8	NA	14.1	14.8	13.9	13.3
Specific Conductivity (mU/cm)	0.864	0.750	0.696	0.567	1.495	NA	1.029	1.421	1.236	1.120
pH (Standard units)	7.13	7.44	7.12	6.81	8.91	NA	7.76	8.81	7.89	8.11

Notes: (1) Samples MW-12B-1 and 12B-2 are duplicated due to aborted pump test
(2) Sample MW-13B-1 was duplicated due to aborted pump test
(3) Samples were diluted due to high levels of analyte

AR360337

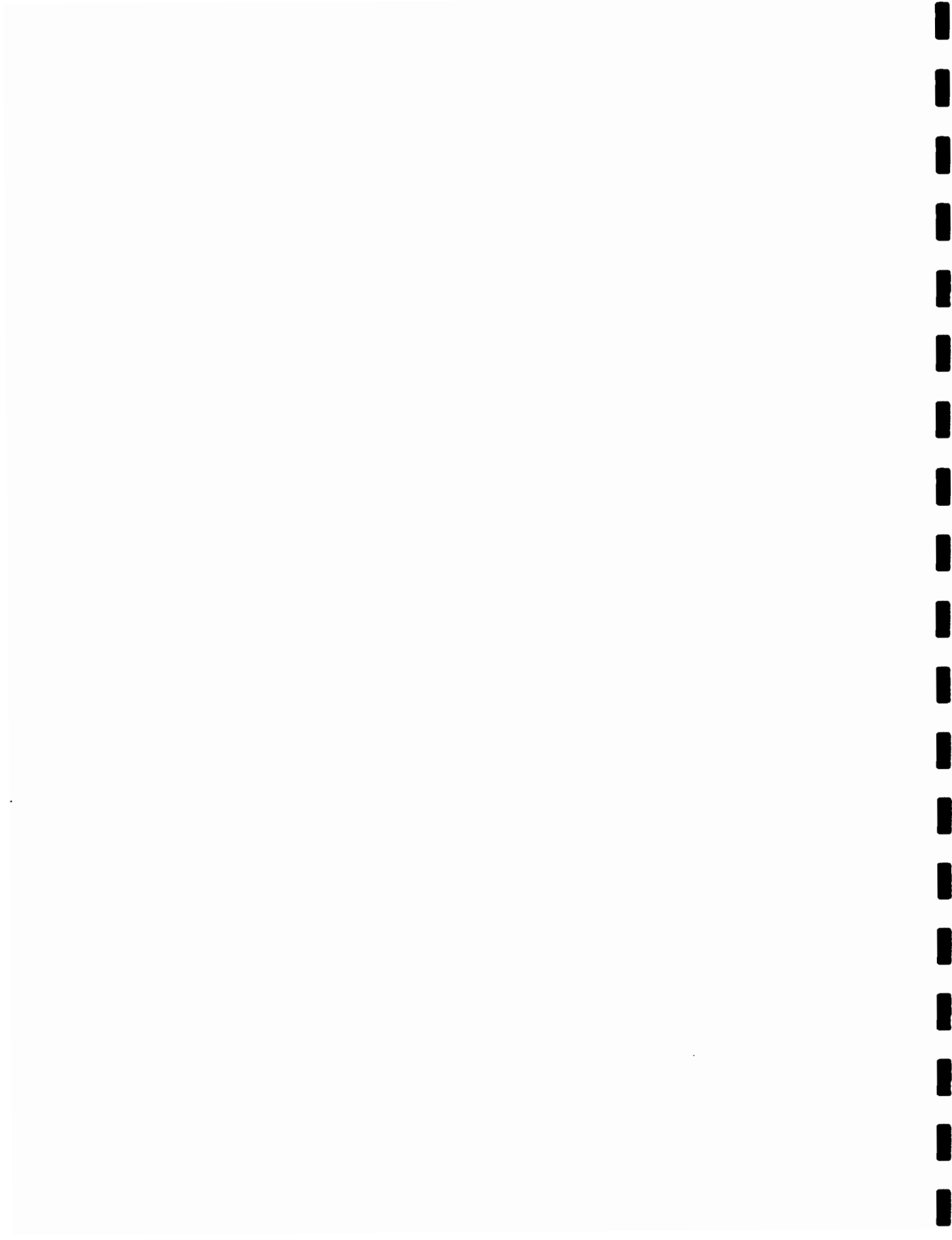


TABLE 4-3 (cont.)
NGK METALS PUMP TESTS
CHEMICAL DATA SUMMARY

WELL	MW-13B						DW-27				
SAMPLE NO.	MW-13B-1	MW-13B-1 (2)	MW-13B-2	MW-13B-3	MW-13B-4	MW-13B-5	DW-27-1	DW-27-2	DW-27-3 (3)	DW-27-4	DW-27-5
LAB PARAMETER (mg/l)											
TSS	410	390	8	<7	<7	<7	650	23	<5	12	31
TDS	1020	1140	730	710	680	680	1040	880	890	890	940
Total Hardness	172	253	158	141	162	162	757	570	551	626	570
Fluoride	29.2	21.2	18.7	18.4	17.6	17.5	5.6	6.0	6.3	6.5	6.9
Sulfate	NA	NA	NA	NA	NA	NA	320	270	280	290	300
Nitrate-Nitrogen	NA	NA	NA	NA	NA	NA	21	18	17	16	16
LAB PARAMETER (mg/l)											
Beryllium	<0.01	<0.01	<0.01	0.01	0.010	0.010	0.141	0.143	0.146	0.153	0.188
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012	<0.010	<0.010	<0.010	0.011
Chromium	0.790	1.09	0.45	0.40	0.38	0.37	0.641	0.752	0.798	0.843	0.954
Copper	0.030	0.03	<0.02	<0.02	<0.02	<0.02	0.699	0.170	0.205	0.206	0.238
Iron	31.0	39.0	0.6	0.3	0.1	0.1	41.4	1.55	0.40	0.61	1.43
LAB PARAMETER (µg/l)											
Methylene Chloride	<1	<1	<1	<1	<1	<1	<1	<1	<10	<1	<1
1,2-DCE (cis/trans)	<1	<1	<1	<1	<1	<1	<1	<1	<10	<1	<1
1,1-DCE	2	8	10	11	11	11	1	1	<10	<1	1
1,1-DCA	4	5	5	6	6	7	<1	<1	<10	<1	<1
1,1,1-TCA	16	41	43	58	61	62	6	6	<10	6	6
1,1,2-TCA	<1	<1	<1	<1	<1	<1	<1	<1	<10	<1	<1
TCE	1	1	2	2	2	2	1	2	<10	3	4
PCE	<1	<1	<1	<1	<1	<1	1	1	<10	1	1
FIELD PARAMETER											
Temperature (°C)	NA	11	11	10	12.4	12.6	14.4	15.3	16.9	16.6	16.6
Specific Conductivity (mU/cm)	1.459	1.498	0.733	1.167	1.117	1.117	1.314	1.098	2.00	1.144	1.174
pH (Standard units)	7.86	7.98	7.70	7.50	7.48	7.43	6.44	6.47	6.69	6.48	6.58

Notes: (1) Samples MW-12B-1 and 12B-2 are duplicated due to aborted pump test
(2) Sample MW-13B-1 was duplicated due to aborted pump test
(3) Samples were diluted due to high levels of analyte



TABLE 4-3 (cont.)
NGK METALS PUMP TESTS
CHEMICAL DATA SUMMARY

WELL	MW-28		MW-29		DW-32				
SAMPLE NO.	MW-28-1	MW-28-2	MW-29-1	MW-29-2	DW-32-1	DW-32-2	DW-32-3 (3)	DW-32-4	DW-32-5
LAB PARAMETER (mg/l)									
TSS	1010	<7	290	<7	330	14	15	11	<5
TDS	1070	1020	740	810	850	870	900	920	920
Total Hardness	695	685	404	422	355	374	439	467	310
Fluoride	2.0	2.5	21.6	17.7	14	10	12	11	11
Sulfate	NA	NA	NA	NA	300	310	310	310	310
Nitrate-Nitrogen	NA	NA	NA	NA	6.7	10.8	11	12	12
LAB PARAMETER (mg/l)									
Beryllium	<0.010	<0.010	0.480	0.360	0.082	0.053	0.052	0.055	0.054
Cadmium	<0.010	<0.010	0.016	0.011	<0.010	0.014	<0.010	<0.010	<0.010
Chromium	<0.050	<0.050	4.48	0.590	0.116	0.168	0.127	0.132	0.131
Copper	0.051	<0.020	5.96	1.07	0.131	0.223	0.087	0.086	0.094
Iron	54.0	0.34	22.2	0.48	19.1	1.87	0.73	0.95	0.37
LAB PARAMETER (µg/l)									
Methylene Chloride	<1	<1	<1	1	<1	<1	<2	<1	<2
1,2-DCE (cis/trans)	<1	<1	6	7	3	2	<2	2	<2
1,1-DCE	<1	<1	<1	<1	49	47	47	57	53
1,1-DCA	2	<1	<1	<1	26	23	25	26	24
1,1,1-TCA	4	3	3	5	130	160	220	210	200
1,1,2-TCA	<1	<1	<1	<1	1	<2	<2	<1	<2
TCE	<1	<1	<1	1	13	10	11	11	10
PCE	<1	<1	2	3	1	1	<2	2	<2
FIELD PARAMETER									
Temperature (°C)	17.8	16.7	17.8	17.5	12.9	14.0	14.3	14.3	14.7
Specific Conductivity (mU/cm)	1.709	1.626	1.17	1.27	1.029	1.074	1.096	1.120	1.136
pH (Standard units)	6.31	7.14	6.39	5.74	6.74	6.82	6.81	6.76	6.89

Notes: (1) Samples MW-12B-1 and 12B-2 are duplicated due to aborted pump test
(2) Sample MW-13B-1 was duplicated due to aborted pump test
(3) Samples were diluted due to high levels of analyte



4.2.1 SW-8

A total of four samples were collected for the test on well SW-8. As shown in Table 4-3, most parameters generally decreased in value or concentration with increased pumping. Beryllium, cadmium, chromium and copper concentrations either slightly decreased or remained relatively unchanged. Total iron decreased from 3.33 to 0.11 mg/l.

The remaining inorganic parameters, total hardness, TSS, TDS, and fluoride, decreased in concentration.

The volatile organic compounds that were detected either decreased in concentration or remain unchanged. DCE, DCA, TCA and TCE were detected in concentrations above the detection limits and decreased slightly with increased pumping time.

Temperature, specific conductivity and pH were measured in the field at the time of groundwater sample collection. Specific conductivity and pH decreased, but the temperature increased slightly. The last pH reading indicates groundwater is slightly more acidic than would be expected for a carbonate (e.g. limestone or dolomite) aquifer. The heat generated from the pump motor most likely warmed up the groundwater slightly since the water level was near the pump intake. The chemical data are summarized in Table 4-3.

4.2.2 DW-12

A total of six groundwater samples were collected from deep well DW-12. Analytical data from three samples collected during an aborted drawdown test, and three samples during a successful test are presented in Table 4-3. The data from each of the respective tests correlate reasonably well with respective inorganic concentrations generally decreasing. Total beryllium, cadmium, chromium, copper and iron were all initially detected at levels higher than at the end of each test. Total beryllium levels ranged from 0.022 to 0.334 mg/l. Cadmium concentrations dropped to below the detection limits in the second and third samples from both tests. Total chromium levels decreased from 0.610 and 0.527 to 0.236 and 0.269 mg/l, respectively. Total iron concentrations improved not only within each of the tests, but also from the beginning of the first test through the end of the second test. An initial concentration of 518 mg/l ultimately decreased to 4.18 mg/l. Purged groundwater from this well has historically been slightly to moderately turbid. Clay and silt particulates account for this turbidity, and are most likely emanating from the mud and clay filled void encountered from approximately 155 to 160 feet.

Fluoride and TDS concentrations generally decreased slightly, while TSS and total hardness decreased significantly with time. Fluoride values ranged from 43.4 - 81.0 mg/l. TDS ranged from 730 - 910 mg/l.

DCE, DCA, TCA and TCE were detected in concentrations above the detection limits and remained relatively unchanged with increased pumping time.



Temperature, specific conductivity and pH decreased from the beginning to the end of the drawdown test. Temperature and pH appear within the typical range of groundwater in a carbonate aquifer in this area.

4.2.3 DW-13

Analytical data from six groundwater samples collected during two separate drawdown tests in deep well DW-13 are shown on Table 4-3. The initial samples were duplicated due to an aborted pump test. The remaining five samples were collected over a four day period. This discussion focuses only on the second drawdown test since there are insufficient data from the first test to identify water quality trends.

Total beryllium concentrations were below detection limits for the first and second sample, while the remaining three samples showed concentrations at the detection limit. Total cadmium was not detected in any sample. Total chromium concentrations decreased from 1.09 to 0.37 mg/l. Total copper was initially detected at 0.03 mg/l with the remaining samples below the detection limit. Total iron levels decreased significantly from 39.0 to 0.1 mg/l.

Fluoride and TDS decreased slightly over time, while TSS improved from 390 to <7 mg/l (detection limit). Fluoride varied from 17.5 to 29.2 mg/l and TDS ranged from 680 to 1020 mg/l.

DCE, DCA, TCA and TCE were detected in concentrations above the detection limits and generally increased slightly over time.

Temperature increased slightly, and specific conductivity and pH decreased slightly. Temperature and pH are within the typical range of anticipated values.

4.2.4 DW-27

A total of five groundwater samples were collected during the four days of pumping DW-27. Total beryllium concentrations increased only slightly from 0.141 mg/l to 0.188 mg/l. Total cadmium remained unchanged. Total chromium increased gradually from 0.641 mg/l to 0.954 mg/l. Total copper decreased from 0.699 mg/l to 0.238 mg/l. Total iron concentrations dropped dramatically from 41.4 mg/l to 1.43 mg/l.

Nitrate-Nitrogen, sulfate, fluoride, TDS and total hardness remained relatively unchanged. TSS improved from 650 mg/l to 31 mg/l.

Volatile organic compounds DCE, TCA, TCE and PCE were detected in low concentrations and remained relatively unchanged throughout the pumping period.

While temperature increased slightly, specific conductivity and pH generally remained unchanged.



4.2.5 DW-28

Two groundwater samples were collected during the first and third day of the drawdown test in deep well DW-28. Total beryllium, cadmium and chromium concentrations were below the respective detection limits. Total copper levels were detected at 0.051 mg/l initially, then below the detection limit. Total iron concentrations decreased from 54.0 to 0.34 mg/l.

Fluoride, total hardness and TDS generally remained constant, and TSS decreased significantly from 1010 to <7 mg/l (detection limit).

Volatile organic compounds were generally found below detection limits or in low concentrations. DCA was detected initially at 2 µg/l then below detection. Low levels of TCA were detected in concentrations of 4 and 3 µg/l, respectively.

Temperature and specific conductivity decreased slightly, while pH increased slightly. Specific conductivity was moderately high and ranged from 1.626 to 1.709 mmhos/cm. Temperature values ranging from 16.7 to 17.8 are moderately high. Since the water level dropped to the pump intake, the pump motor probably heated the water slightly.

4.2.6 DW-29

Two groundwater samples were collected during the first and third day of the drawdown test in deep well DW-29. All total metals concentrations were above the respective detection limits, but decreased with increased pumping time. Total beryllium and cadmium decreased slightly, and chromium, copper and iron decreased significantly from 4.48, 5.96 and 22.2 to 0.59, 1.07 and 0.48 mg/l, respectively.

Fluoride decreased slightly from 21.6 to 17.7 mg/l and total hardness and TDS increased slightly. TSS decreased from 290 to <7 mg/l.

Volatile organic compounds DCE and DCA were not detected above the detection limit. Methylene chloride was detected at 1 µg/l in the second sample. This is most likely due to laboratory contamination. 1,2-DCE, TCA and PCE were detected in low levels and increased with pumping time by 1 µg/l each.

Temperature and pH decreased slightly, while specific conductivity increased slightly. The temperature was moderately high. Although the water level during the drawdown test reached the pump intake, it is unlikely that the pump motor impacted the temperature significantly since the well sustained a pumping rate of 74 gpm. A final pH of 5.74 is moderately more acidic than typical groundwater pH values of 7 or greater for the area.

4.2.7 DW-32

Throughout the four days of pumping DW-32, a total of five groundwater samples were collected. Total beryllium, cadmium, chromium and copper concentrations remained relatively



unchanged. Cadmium was generally detected in low concentrations just above the 0.010 mg/l detection limit. Total iron dropped from 19.1 to 0.37 mg/l during the testing period.

TDS, total hardness, fluoride, sulfate and nitrate-nitrogen concentrations were relatively unchanged or increased slightly. TSS improved from 330 mg/l to <5 mg/l (detection limit).

1,2-DCE, DCE, DCA, TCA, 1,1,2-TCA, TCE and PCE were detected in concentrations above the detection limits. DCE, DCA, TCA, and TCE concentrations are slightly elevated, while the other compounds were low or near detection limits.

Specific conductivity and pH were generally stable, while temperature increased slightly over time.



5.0 HYDRAULIC CONTAINMENT

5.1 INTRODUCTION

The following section combines the results of the aquifer tests described previously along with data collected during the testing of monitor wells SW-9 and SW-19. Although a drawdown/recovery test was previously conducted on shallow well SW-15, the area of influence was minimal and the observed drawdowns in the observation wells were insignificant. Therefore, this well will not be considered as a viable groundwater extraction point. However, the drawdown/recovery tests that were completed on wells SW-9 and SW-19 produced more favorable results in terms of size of the area of influence and sufficient drawdown in observation wells. Further, these two wells are located near the center of the site and within the principal Solid Waste Management Units (SWMUs) area.

Specific details and quantitative analysis of the individual tests conducted on wells SW-9 and SW-19 are found in previous reports. Pertinent information from these tests is presented in the following discussion to assist in the development of an effective groundwater hydraulic containment system. Considering all available information, groundwater containment is achievable in two primary areas of concern. These two areas are near the northeast and southwest corners of the site, respectively. It is anticipated that a network of groundwater extraction wells located in these areas will effectively contain contaminated groundwater emanating from known sources, minimize contaminated groundwater from migrating off-site and provide a mechanism to transport contaminated groundwater to an appropriately designed water treatment facility located on site. Although the proposed hydraulic containment system focuses on the two respective areas, it is anticipated that positive impacts to groundwater quality will be realized site-wide.

In the following narrative both the northeast and southwest hydraulic containment systems are discussed. The recommended well configurations and pumping rates are based upon both static and drawdown water level data and known groundwater quality data. The selected groundwater extraction wells for both the northeast and southwest systems are primarily chosen so as to prevent the migration of chemical constituents from the site by controlling migration from known source areas. The system is not intended to capture impacted groundwater that has migrated off-site or to remote areas of the site. The hydraulic containment system is designed to capture affected chemical constituents in groundwater and prevent further migration to those areas.

Along with groundwater chemical data, drawdown data were the primary source of data used to select which wells should be used to achieve groundwater hydraulic containment. Although drawdown data were considered to be adequate quality, pumping would have had to continue for longer periods of time to allow the aquifer system to reach equilibrium. The drawdown data indicate that the areas of influence were still growing (expanding and deepening) before the tests were terminated. Therefore, it can be assumed that the estimated areas of capture presented in

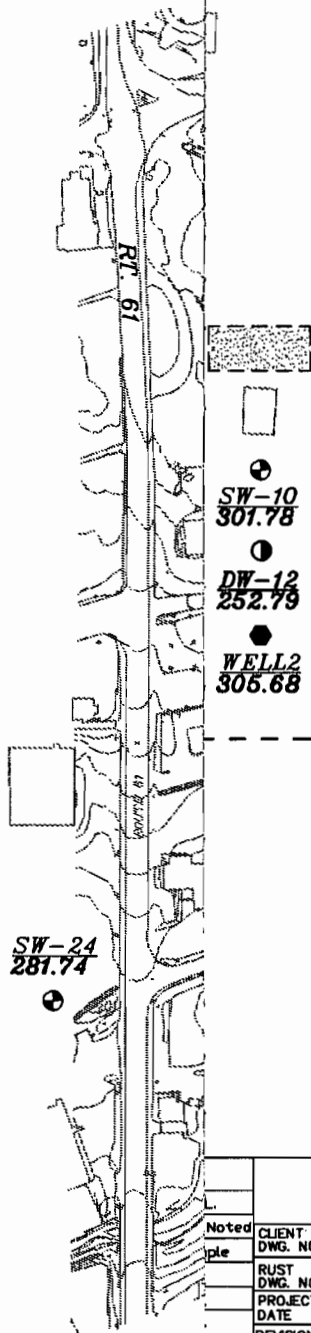


NOTES:
 BASE MAP MATERIAL WAS COMPILED AND COMPLETED
 BY AERIAL DATA REDUCTION ASSOCIATES, INC.
 280 KAPPA DRIVE, PITTSBURGH, PENNSYLVANIA 15228

GROUNDWATER CONTOUR INTERVAL = 5'

TOPOGRAPHIC CONTOUR INTERVAL = 3'

WELLS NOT SHOWING ELEVATION DATA WERE NOT MONITORED



LEGEND

SOLID WASTE MANAGEMENT UNIT

SITE FEATURES

SHALLOW MONITOR WELL
 GROUNDWATER ELEVATION

DEEP MONITOR WELL
 GROUNDWATER ELEVATION

LANDFILL WELL
 GROUNDWATER ELEVATION

PROPERTY LINE

RUST ENVIRONMENT & INFRASTRUCTURE

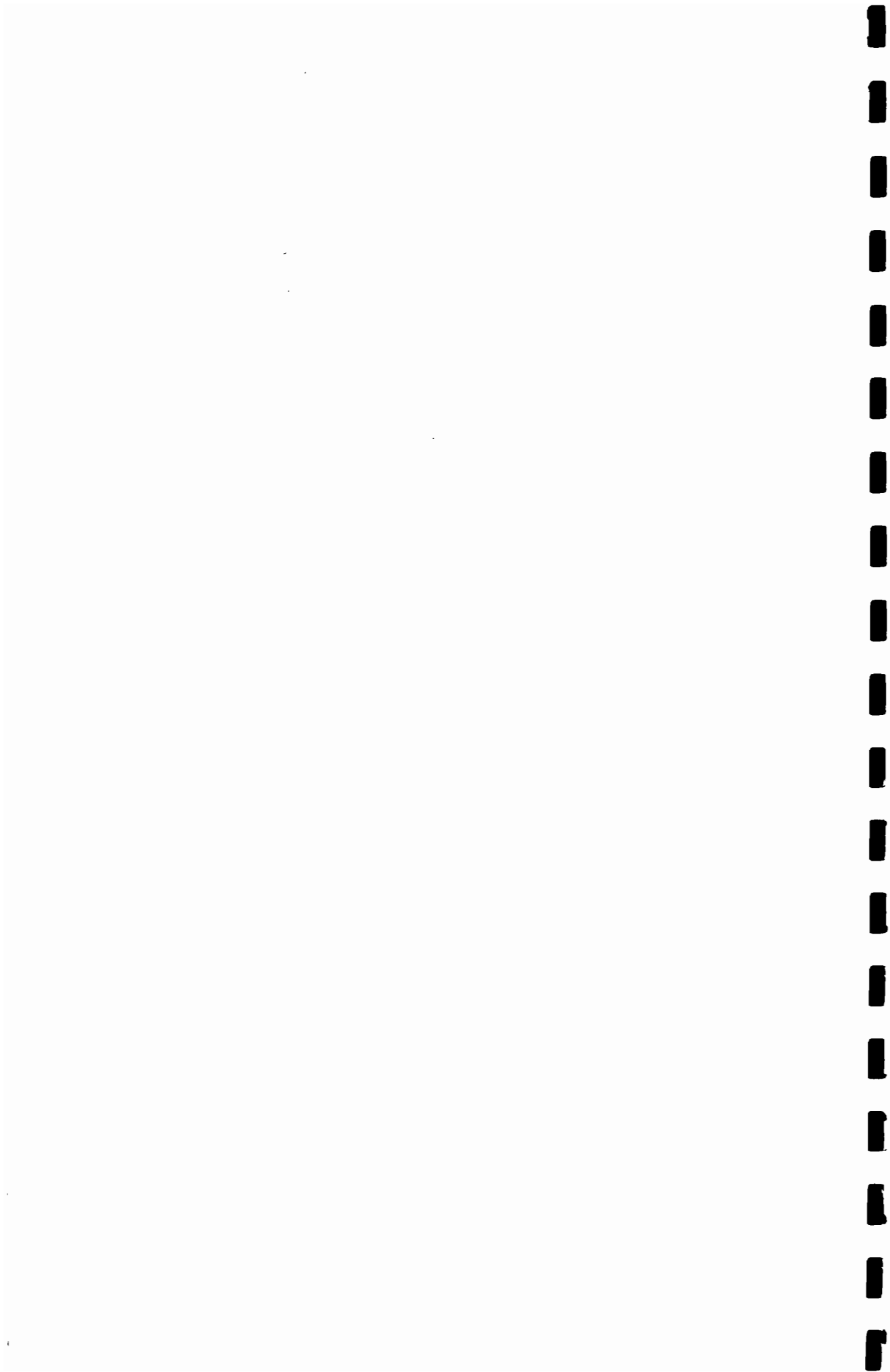
2 Market Plaza Way
 Mechanicsburg, PA 17055
 (717) 765-8001
 (717) 765-8220 Fax

CLIENT:	
DWG. NO.	
RUST DWG. NO.	
PROJECT NUMBER	35525.300
DATE	
REVISION NUMBER	
SHEET NUMBER	
OF	

FIGURE 5-1
 CUMULATIVE DRAWDOWN MAP USING PUMP TEST
 MAXIMUM DRAWDOWNS FOR SELECTED RECOVERY WELLS
 NGK METALS CORPORATION
 Berks County, Pennsylvania

CAD FILE NAME: FULLPUMPTESTSITE
 PLOT DATE:

AR360345



this report are minimum areas of capture that will become larger with time. Also, during the drawdown testing of wells DW-27 and DW-32, the groundwater levels at the site were at all time high levels since water level monitoring started in November of 1989 (see well hydrographs in Appendix F). Because the water levels were high and infiltration was occurring, areas of influence created by drawdown testing of wells DW-27 and DW-32 probably are not as large as they would have been during periods of more typical (i.e. lower) groundwater levels. Knowing this, recommended withdrawal rates have been carefully selected and take into account that some additional expansion will occur until equilibrium conditions are reached.

Additionally, drawdown data indicate that water levels in the shallow well system generally did not respond as much as the deep well counterparts when the deep wells were pumped. However, it is believed that when the aquifer system has been pumped for a sufficient duration (i.e., equilibrium), these shallow water levels will ultimately be fully impacted and mimic the water levels of the deeper wells within the area of influence. The shallow wells are more typically installed within the upper 100 feet of the surface and their open interval intersects more saturated soil profile than the deeper wells. As a result, it is expected that the shallow water levels will take a longer period of time to drain under the influence of gravity when compared to the more open fractured and solutioned bedrock that the deeper system typically intersects.

After the hydraulic containment system has been in operation and the aquifer system has achieved equilibrium, it is expected that naturally rising and falling groundwater levels (responding to periods of high and low infiltration) will continue to impact the areas of influence. When groundwater levels rise and fall the areas of influence will shrink and expand accordingly. As a result, a portion of the aquifer (the portion of the aquifer that is rewetted during a water level rise) will benefit from the resulting "flushing" action. Additional flushing will occur when a withdrawal well is taken off-line for unexpected or routine maintenance events.

5.2 GROUNDWATER COLLECTION SYSTEM - NORTHEAST

In the northeast portion of the site a former Retention Pond is a known source area for groundwater contamination. Chemical data indicate that groundwater in several wells in this area have been adversely impacted by this pond. Essentially, the pond is believed to be the primary source of chemical constituents in the groundwater. In addition to the Retention Pond, it is believed that former Pond 1 may be a contributing source to groundwater contamination in the northwestern wells. Therefore, groundwater hydraulic containment is necessary in this area. Sampling and analysis of groundwater collected from well DW-27 and DW-28 also indicated that groundwater contamination existed around well DW-27 but not DW-28. Because of these data, the area near well DW-27 was added to the area to be hydraulically contained. As a result, two wells (DW-27 and DW-29) were selected to create hydraulic containment in the area of the former Retention Pond.

Aside from shallow well SW-15, deep wells DW-27, DW-28 and DW-29 were pump tested in the northern one-half of the site. The radial area of influence (measured parallel to Tuckerton Road) from pumping well DW-28 was less than 200 feet and apparently was capable of directly



impacting shallow well SW-21. Comparatively, the pumping data indicate that wells DW-29 and DW-27 each created a larger resultant area of influence. Both wells separately created an area of influence that appeared to extend in an east-west direction (parallels Tuckerton Road). Total diameter of influence (oriented along Tuckerton Road) for these wells combined is an estimated 600 to 700 feet. Well DW-28 is unnecessary as a withdrawal well because of the limited area of influence, anticipated low well yield (<5 gpm), and good water quality test results from groundwater samples collected during the drawdown test.

The area of influence created by pumping well DW-29 appears to have extended to just beyond shallow well SW-14 to the east and well DW-28 to the west. Pumping DW-29 created an area of influence more than sufficient to capture and contain groundwater beneath the entire former Retention Pond located in the northeast portion of the facility property. Pumping of well DW-29 is particularly important because the area of capture should prevent the migration of contaminated groundwater towards well SW-14 from both the former Retention Pond and former Pond 1. Historically, static water level contour maps have suggested that there is a groundwater hydraulic flow potential moving groundwater off-site to the northeast. Data from the drawdown test conducted on well DW-29 suggest that groundwater containment in the northeast corner of the site is achievable by pumping well DW-29 at a rate slightly less than the drawdown test rate of 74 gpm. Because the production rate of the well decreased (115 to 74 gpm) during the drawdown test, it is believed that the production rate will continue to drop until long term equilibrium is established within the aquifer. Therefore, an initial withdrawal rate of about 50 gpm is suggested for well DW-29.

The area of influence created by pumping well DW-27 appears to have extended just beyond well DW-28 to the east and nearly to well set 16 to the west. Pumping DW-27 created an area of influence larger than necessary for hydraulic containment in the area of well DW-27. Because groundwater at well DW-28 was clean, it is not necessary to create overlapping cones of depression. The area of influence created by drawdown testing well DW-27 extended beyond well DW-28 by an estimated 200 feet. To reduce the area of influence by about 200 feet so that it reaches just past well DW-28 will require a lesser pumping rate than was used for the drawdown testing. The new area of influence needs to be about 400 feet or approximately 57 to 66% of the estimated 600 to 700 foot total area of influence created by the drawdown test. Assuming that the drawdown test pumping rate needs to be adjusted similarly, then it is estimated that the well needs to be pumped at about 50 to 56 gpm.

Along the northeastern perimeter of the site, wells DW-27 and DW-29 will be sufficient to create drawdown zones (i.e. areas of capture) necessary to prevent off-site migration of groundwater. Pump test data suggest that the cumulative effect of pumping these wells may be overlapping areas of influence, although groundwater chemical data suggest that overlapping cones of depression will not be necessary in the area of DW-28. Shown on Figure 5-1 is a perspective of groundwater hydraulic containment system contour map that collates the area of influence data from well drawdown testing. Maximum drawdown data were combined and then subtracted from static groundwater levels collected on April 5, 1994. Figure 5-1 only shows cumulative drawdown data for the wells chosen to be used in the hydraulic containment system. The figure



should only be used as a guide to better visualize the combined effects created by the drawdown testing.

After the hydraulic containment system has been in operation and the aquifer system has achieved equilibrium, it is expected that naturally rising and falling groundwater levels (responding to periods of high and low infiltration) will continue to impact the areas of influence. When groundwater levels rise and fall the areas of influence will shrink and expand accordingly. As a result, a portion of the aquifer (the portion of aquifer that is rewetted during a water level rise) will benefit from the resulting "flushing" action. Additional flushing will occur when a withdrawal well is taken off-line for unexpected or routine maintenance events.

5.3 GROUNDWATER COLLECTION SYSTEM - SOUTHWEST

Chemical data indicate that groundwater in several wells in the southwestern portion of the site have been impacted by known (hydraulically) upgradient sources. These include Pond 2, Pond 3, and two red mud disposal areas located near the center of site. Groundwater from these source areas flows southwest. Historical water level data indicate this is the principal direction of groundwater flow in the southwestern area of the site. Groundwater hydraulic containment is necessary in this area to prevent off-site migration. As a result, a minimum of two wells are recommended (DW-12 and DW-32) to create hydraulic containment across the southwestern portion of the site. If necessary, well SW-8 could be added to enhance the hydraulic containment. As an alternative, data also suggest that hydraulic containment can be achieved along the southwestern perimeter of the site by pumping a combination of wells DW-12 and DW-32 in conjunction with injection to wells DW-8 and DW-13.

Aside from shallow wells SW-9 and SW-19, shallow well SW-8 and deep wells DW-12, DW-13 and DW-32 were pump tested in the southern one-half of the site. After drawdown data were reviewed wells SW-8, DW-12, and DW-32 were selected for further analysis as potential withdrawal wells. Wells SW-9 and SW-19 are not considered as groundwater extraction wells due to specifications of the proposed cap in this area.

Evaluation of water level data collected during the drawdown test at DW-13 indicates that the area of influence extended to Well 4 and well set 8 and as far as well DW-12 about 400 feet upgradient from well DW-13. As a result, the estimated total area of influence was about 800 feet, assuming the area of influence is symmetrical. However, due to the widespread number of wells in the extreme southwest corner of the site, the estimate of influence is only approximate. After careful evaluation of the other well drawdown test results, well DW-13 was eliminated as a possible extraction well because of location and the large rates of groundwater extraction that would create a smaller size area of capture than would pumping wells DW-32 and SW-8. However, well DW-13 is a prime candidate for receiving fairly large volumes of treated groundwater if used as an injection point.

The area of influence created by pumping well DW-12 appears to have extended to just beyond shallow well SW-8 and Well 4 to the northwest and well SW-12 to the east. Pumping DW-12

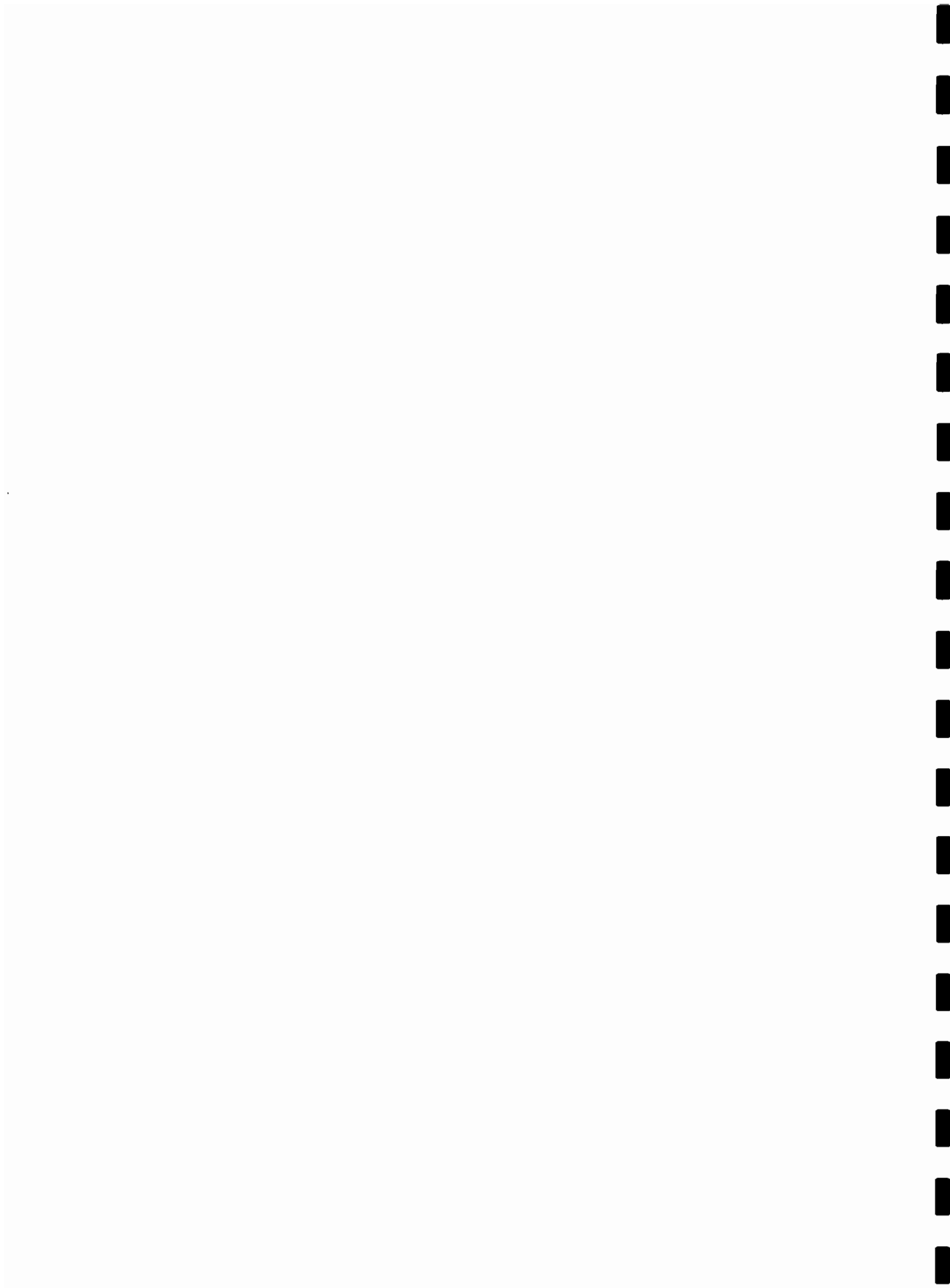


created an area of capture estimated to total about 500 to 600 feet (along the axis of pumping wells DW-12 and Well 4), assuming that the area of capture extends towards Laurel Run and is symmetrical. Drawdown data indicate that Well 4 was significantly impacted by pumping DW-12 and to a lesser degree well set 8. The resulting evaluation of maximum drawdown water level elevations indicated that the water level drop seen in Well 4 was insufficient to reverse groundwater flow from the area of well set 8 and cause it to flow towards Well 4. Therefore, the area of capture was smaller than anticipated. However, drawdown data suggest that groundwater containment in the southwest corner of the site is achievable by pumping well DW-12 in conjunction with DW-32. To increase drawdown at Well 4, the rate of withdrawal for well DW-12 should be at a rate somewhat higher than the drawdown test rate of about 110 gpm. Therefore, an initial withdrawal rate of about 140 gpm is suggested for well DW-12. A withdrawal rate of 140 gpm represents an increase in pumping of about 27%.

The area of influence created by pumping well DW-32 appears to have extended just beyond well SW-7 to the northeast and nearly to Well 4 to the southeast. Pumping DW-32 created an area of influence estimated to total 400 feet, assuming the area of influence is symmetrical. Only well SW-7 was clearly impacted by pumping. However, data suggest that Well 4 and probably well DW-8 were impacted to a lesser extent. It is recommended that well DW-32 be pumped at the maximum production capacity of the well of about 9 gpm. In this way, the maximum area of capture may be realized from this well.

Drawdown data indicate that the estimated area of influence created by pumping well SW-8 to total 400 feet, assuming the area of influence is symmetrical. Wells DW-8, DW-13 and Well 3 were the only wells clearly impacted by pumping. Data also indicate that Well 4 was possibly impacted but only slightly. If necessary well SW-8 could be added to the hydraulic containment system to capture ground water escaping from between Well 4 and well DW-12. However, it is recommended that well SW-8 only be considered as a withdrawal well if deemed necessary. As stated above, an alternative to adding withdrawal wells would be to use well SW-8 and/or well DW-13 as injection points for treated ground water.

Actual pump test data collected from wells DW-12 and DW-32 suggest that overlapping cones of depression may develop after longer term pumping allows the ground water system to fully achieve equilibrium. Development and maturation of the overlapping cones of depression will likely be enhanced by the installation of the remedial RCRA caps over the various past disposal areas. The resulting overlapping cones of depression would approximately create a capture zone up to as much as approximately 1000 to 1200 feet in length if pumped simultaneously (through the axis of pumping wells DW-12 and 32). Therefore, it is believed that the total ground water withdrawal rate from the two wells would be about 150 gallons per minute. If after long term pumping the cones of depression do not overlap, then well SW-8 may need to be added to the hydraulic containment system. However, if it is determined that well SW-8 needs to be added to the system, total withdrawal from wells DW-12 and 32 would likely be reduced to offset the increase.



Shown on Figure 5-1 is a perspective of ground water hydraulic containment system contour map that collates the area of influence data from well drawdown testing. Maximum drawdown data were combined and then subtracted from static ground water levels collected on April 5, 1994. Figure 5-1 only shows cumulative drawdown data for the wells chosen to be used in the hydraulic containment system. The figure should only be used as a guide to better visualize the combined effects that were created by the drawdown testing.



6.0 CONCLUSIONS AND RECOMMENDATIONS

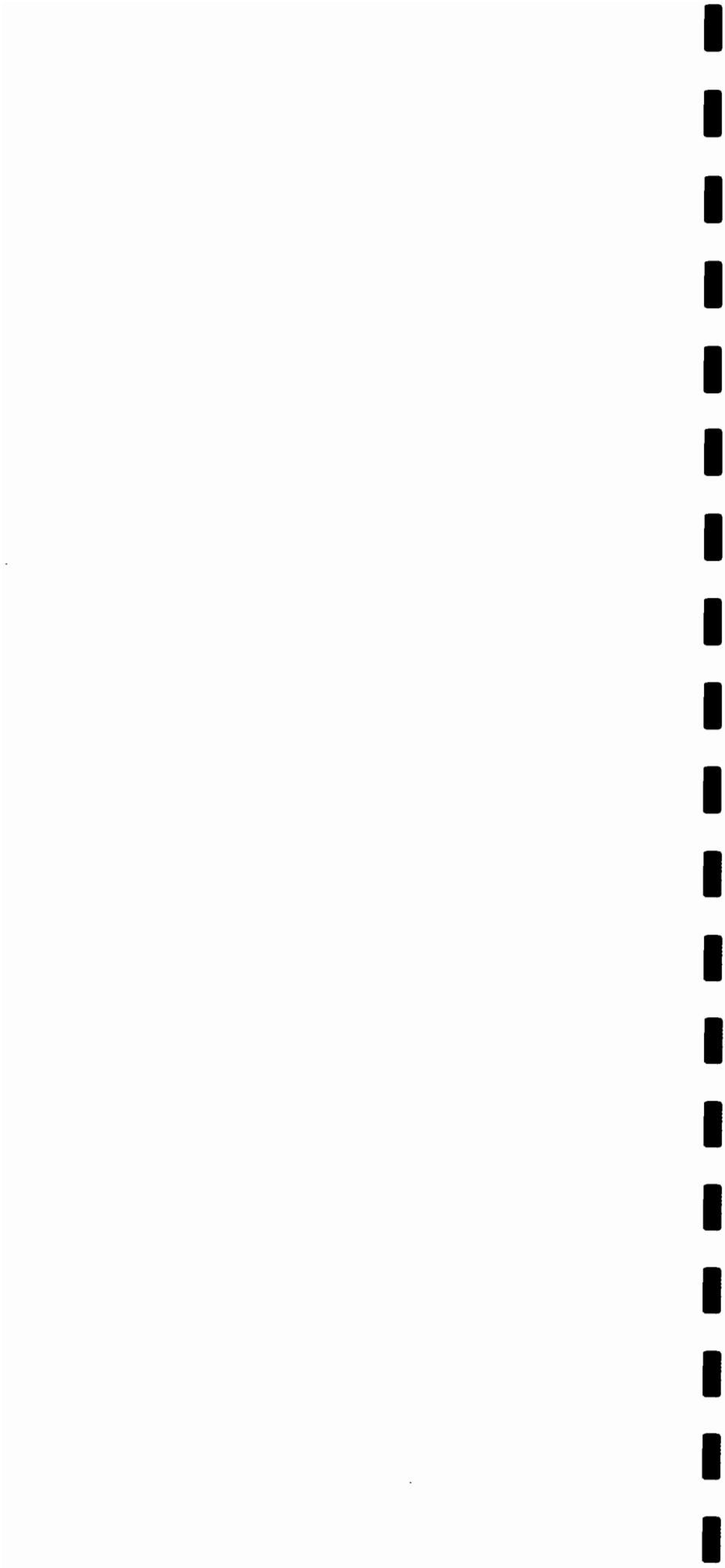
6.1 CONCLUSIONS

6.1.1 General

1. Apparent ground water elevations and flow directions within the shallow (<100 feet) and deep (>100 feet) portions of the water table aquifer have remained consistent since previous investigations.
2. Drawdowns were measured in several observation wells for the respective pump tests conducted on wells SW-8, DW-12, DW-13, DW-27, DW-28, DW-29 and DW-32.
3. The seven pump tests, generally produced favorable results in terms of significant (i.e. <1 foot) drawdowns in several monitor wells greater than 150 feet away. This was the maximum radius of influence from three previous pump tests.
4. Generally, few wells located in the northern portion of the site exhibited reasonable yield (i.e. 5 gpm or more) to be considered for recovery wells. Four of the five new wells produce an estimated 5 gpm or better.
5. Overall pump test were of sufficient quality to determine approximate areas of influence and to provide adequate information to estimate pumping rates of selected wells to be used for groundwater extraction.
6. Based on available information, an initial estimate for cumulative pumping rate from four extraction wells (DW-12, 27, 29 and 32) is approximately 250 gpm.
7. Groundwater quality generally improved with time during pumping of wells SW-8, DW-12, DW-13, DW-28 and DW-29. Groundwater quality diminished slightly or remained relatively unchanged at wells DW-27 and DW-32.

6.1.2 Pumping Well SW-8

1. Well SW-8 was pump tested for approximately three days at an average rate of 28 gpm. Pumping rate varied from 30 gpm initially to 22 gpm near the end of the test.
2. The measured maximum drawdown in SW-8 was 14.04 feet, which was at the pump intake. The corrected drawdown, which accounts for the natural trend of the water table, was 13.69 feet.
3. Well 3, DW-13, and DW-8 with 1.30 feet, 1.25 feet and 1.15 feet of (corrected) drawdown, respectively, were apparently impacted the most due to pumping of SW-8.



4. The apparent effective radius of influence reaches well DW-13, which is approximately 250 feet away.

6.1.3 Pumping Well DW-12

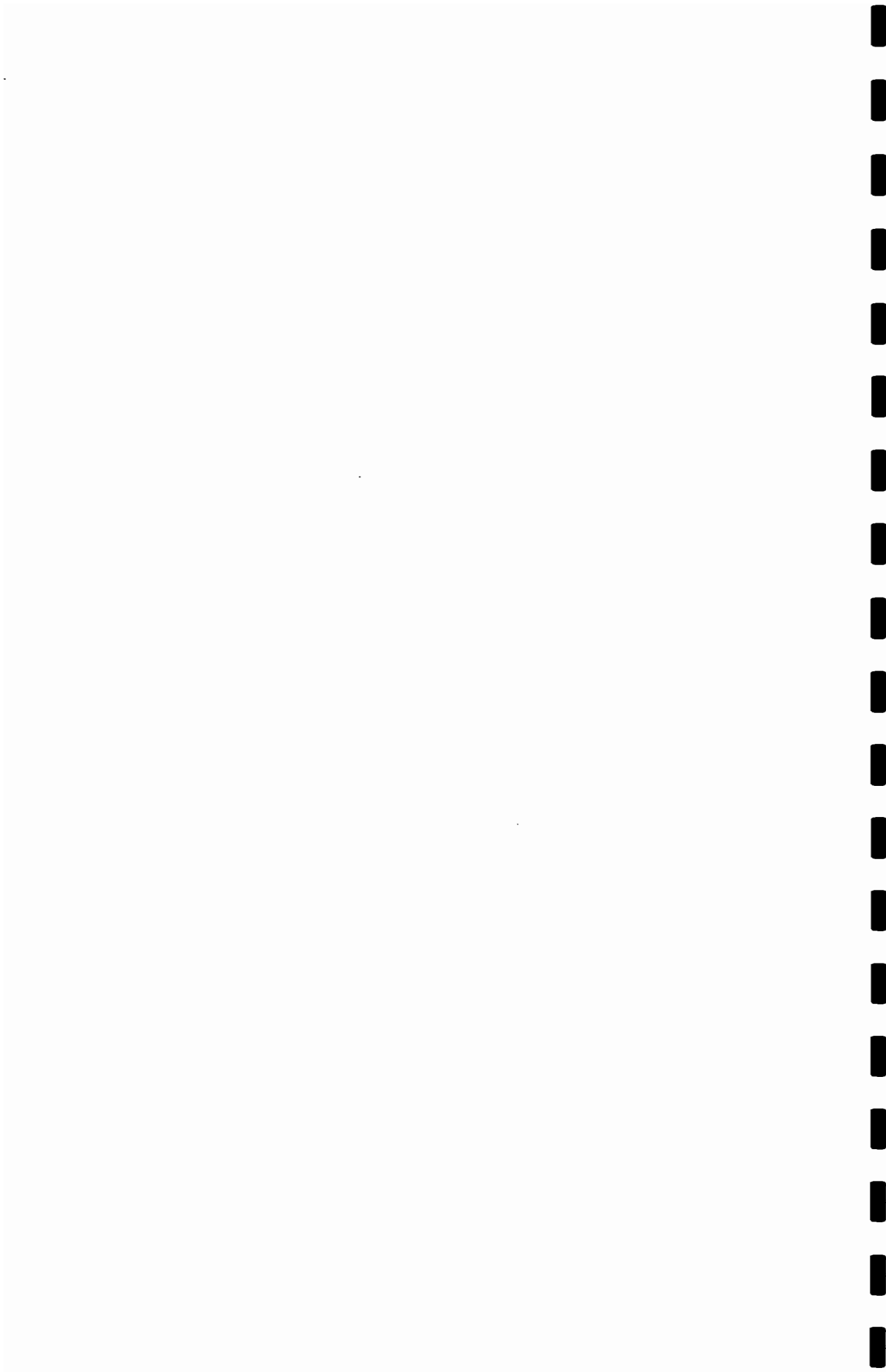
1. Well DW-12 was pump tested for approximately four days at an average rate of 105 gpm. Pumping rate varied from 111 gpm, initially to 95 gpm near the end of the test.
2. The measured drawdown in pumping well DW-12 was 42.86 feet. Corrected drawdown was 42.11.
3. Monitored observation wells exhibiting more than one foot of drawdown (corrected for natural site-wide water table trends) include Well 1, Well 3, Well 4, SW-8, SW-12 and DW-13:
4. The radius of influence appears to extend to beyond well SW-8, which is more than 600 feet away.

6.1.4 Pumping Well DW-13

1. Well DW-13 was pump tested for approximately seven days at an average rate of 87 gpm. Pumping rate varied from 96 gpm, initially to 85 gpm near the end of the test.
2. The measured drawdown in pumping well DW-13 was 38.29 feet.
3. Monitored observation wells exhibiting more than one foot of drawdown (corrected for natural site-wide water table trends) include Well 1, Well 3, Well 4, SW-8, DW-12 and DW-8.
4. The apparent radius of influence extends to observation well DW-12, which is approximately 400 feet away.

6.1.5 Pumping Well DW-27

1. Well DW-27 was pump tested for four days at a rate of 90 gpm which gradually decreased to 85 gpm.
2. The measured (uncorrected) drawdown in pumping well DW-27 was 32.84 feet.
3. Water levels in wells DW-28, SW-23 and DW-15 were impacted the most due to pumping. Respective drawdowns were 7.36 feet, 3.06 feet and 2.03 feet.
4. The apparent area of influence extends towards the east to at least well SW-23, and towards the southeast to at least well DW-15. These wells are approximately 325 and 300 feet from the pumping well, respectively.



6.1.6 Pumping Well DW-28

1. Well DW-28 was pump tested for approximately three days at an average rate of 8 gpm. Pumping rate varied from 15 gpm, initially to 4 gpm near the end of the test.
2. The measured (uncorrected) drawdown in pumping well DW-28 was 40.40 feet.
3. SW-21 and SW-23 with 7.06 feet and 0.91 feet of (corrected) drawdown, respectively, were apparently impacted the most due to pumping of DW-28.
4. The apparent radius of influence extends to observation well SW-21, which is approximately 230 feet away. Well SW-21 appears to be uniquely connected to the pumping well, since observed drawdowns in wells located between the two were insignificant relative to the drawdown in SW-21.

6.1.7 Pumping Well DW-29

1. Well DW-29 was pump tested for approximately three days at an average rate of 87 gpm. Pumping rate varied from 115 gpm, initially to 74 gpm near the end of the test.
2. The measured drawdown in pumping well DW-29 was 41.39 feet. Corrected drawdown in the pumping well was 41.28 feet.
3. Monitored observation wells exhibiting more than one foot of drawdown (corrected for natural site-wide water table trends) include SW-14, SW-23, DW-15, DW-28 and DW-30.
4. The apparent radius of influence extends to observation well DW-28, which is approximately 300 feet away.

6.1.8 Pumping Well DW-32

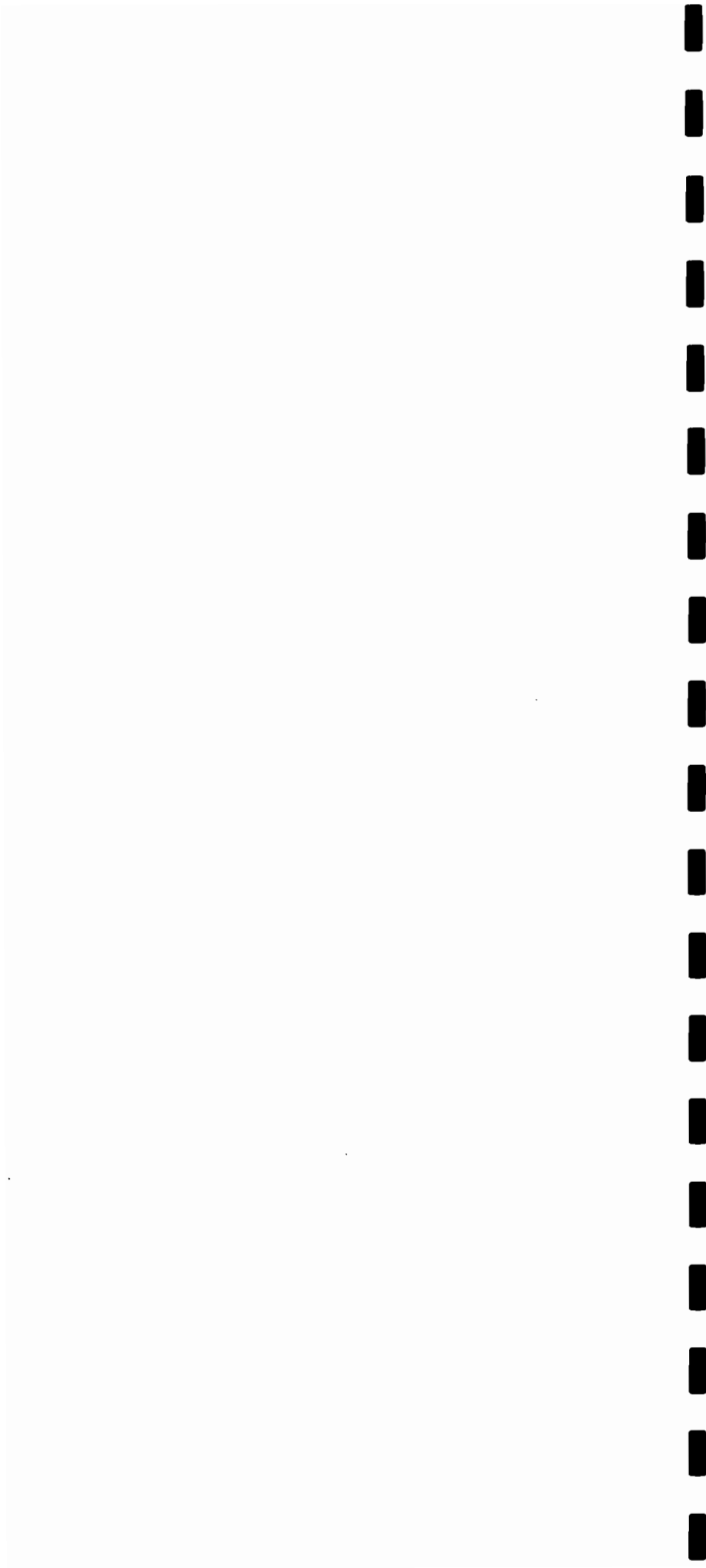
1. Well DW-32 was pump tested for approximately four days at a rate of approximately 9 gpm.
2. The measured (uncorrected) drawdown in pumping well DW-32 was 63.19 feet.
3. Well SW-7, located approximately 200 feet away, was the only well that showed drawdown of at least one foot. The drawdown was 2.28 feet.
4. Pumping well DW-32 created an area of influence that extended to beyond well SW-7 towards the northeast and nearly to Well 4 towards the southeast. Well 4 is located approximately 260 feet from DW-32.



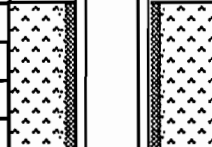
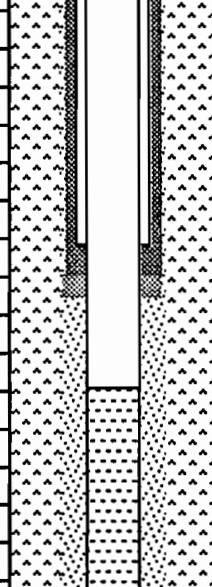

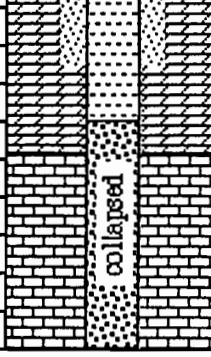
APPENDIX A

WELL LOGS

AR360354

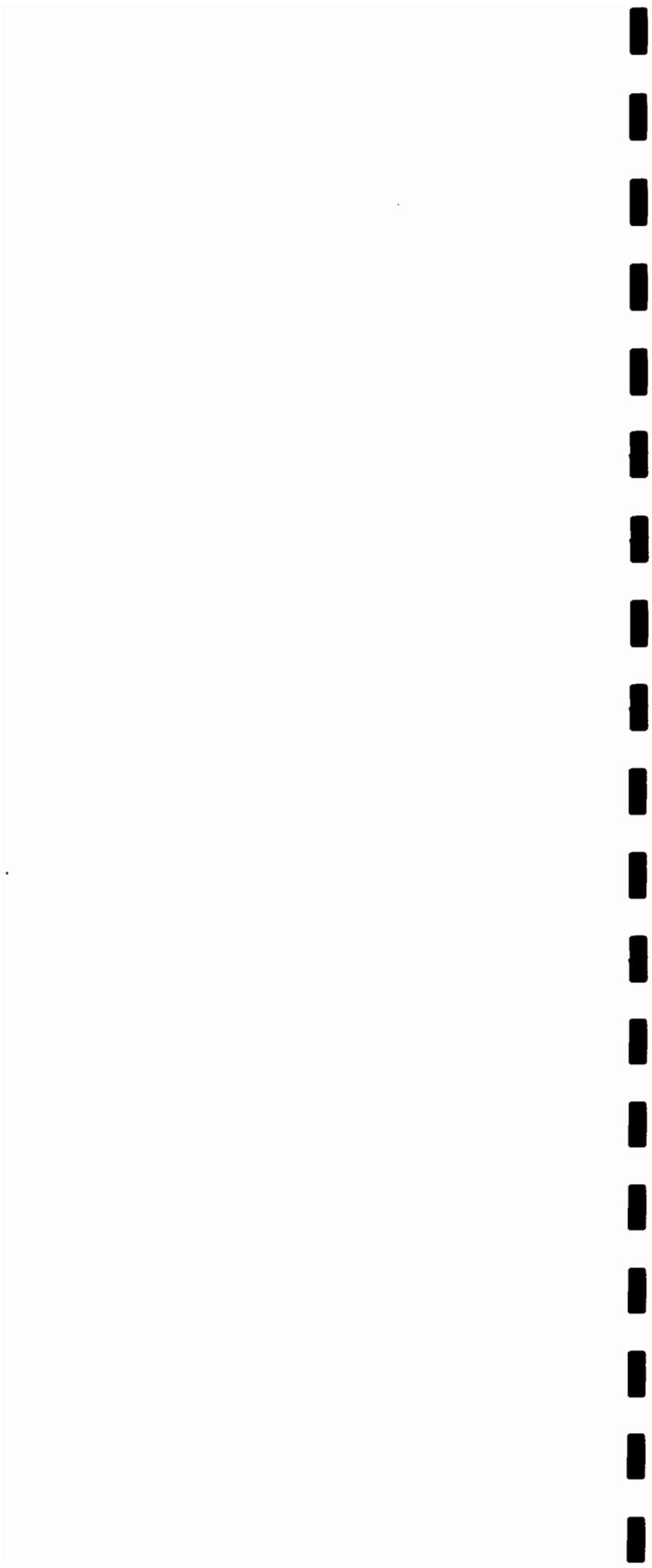


Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-5A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : C. Knaub		Total Depth 48 ft.	
Geologist : J. J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 8/28/89	
Time Log: Begin Finish Depth				Casing steel 6 in.		Notes: 4 in. pvc .02 slot screen from 48'-28'; #1 morie sand	
				Bore rock/unconsol. 10 in.		48'-36', 1B quartzite	
				Well pvc 4 in.		36'-23', bentonite 23'-22.5', grout 22.5'-0'	
				Sampler		Date Finished 9/15/89 S.W.L. 25.55 ft. <u>TOC/GL</u> Elevation TOC Surface 329.56 ft. 327.42 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-9'				red clay (mud), sand, quartzite gravel (fill), dolomite fragments.	damp
10-40'				light brown clay, sand, and gravel	wet
40-41'				large gravel or broken carbonate rock	estimated water ~2 gpm
41-60'				intermittent weathered, dark grey, pyritic shale and dolomite grades to limestone with mud filled voids	

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Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No.MW-5A

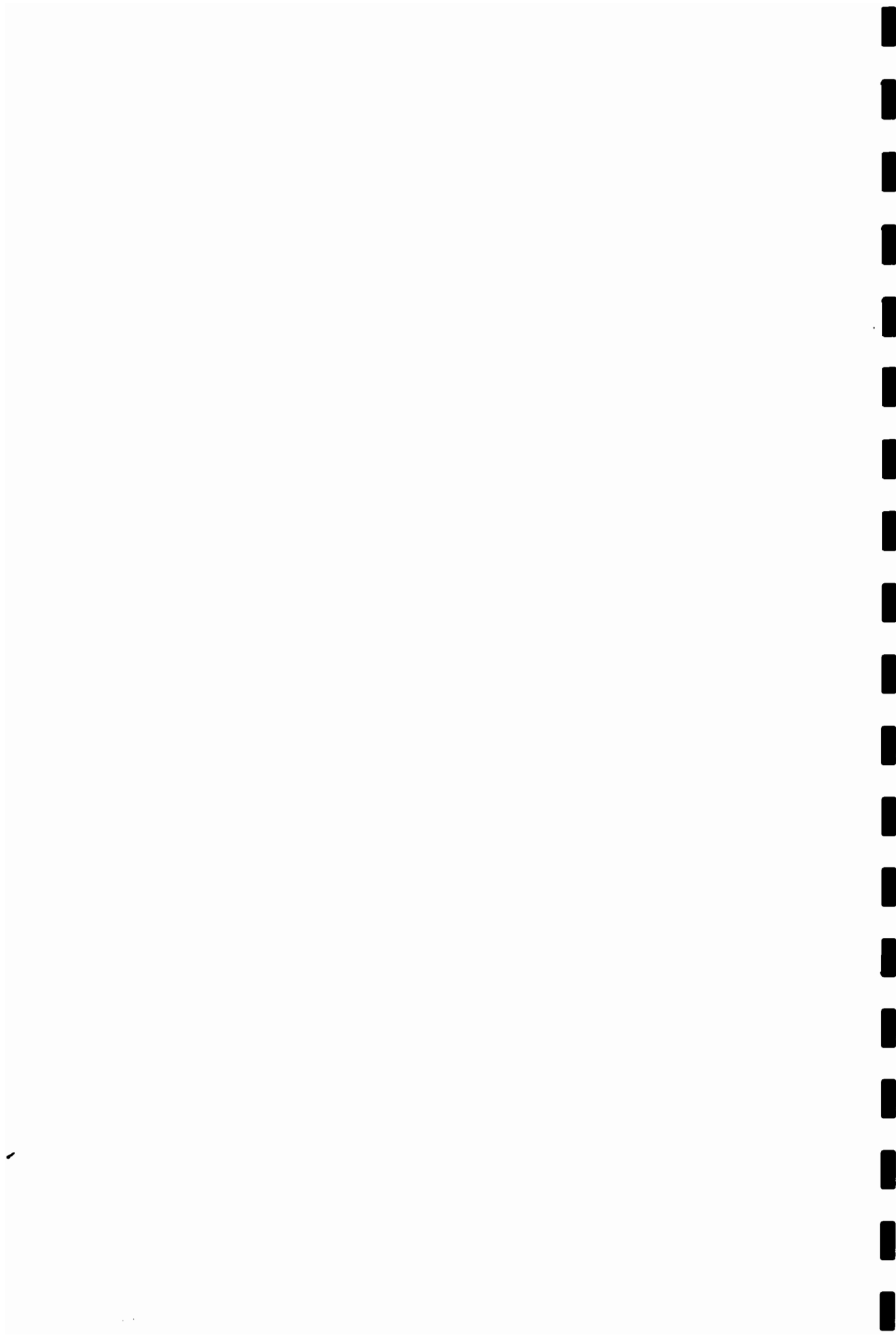
Client : NGK Metals Corporation

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-61' weathered dolomite	60-100' very little to no return of drill cuttings, added foam to help re-turn cuttings
				61-69' mud/water filled void	
70				69-71' medium to dark grey dolomite	
				71-72' void	
				72-73' medium to dark grey dolomite	
				73-93' intermittent medium to dark grey dolomite/voids	
80					note: while reaming the bore hole, cuttings returned: dolomite, quartzite pebbles and gravel, quartz fragments, shale, leached dolomite
90				93-100' competent bedrock medium grey dolomite	the 6 in. steel casing was pulled back and the hole stayed open to 45' and well was constructed
100					final estimated flow is >10 gpm

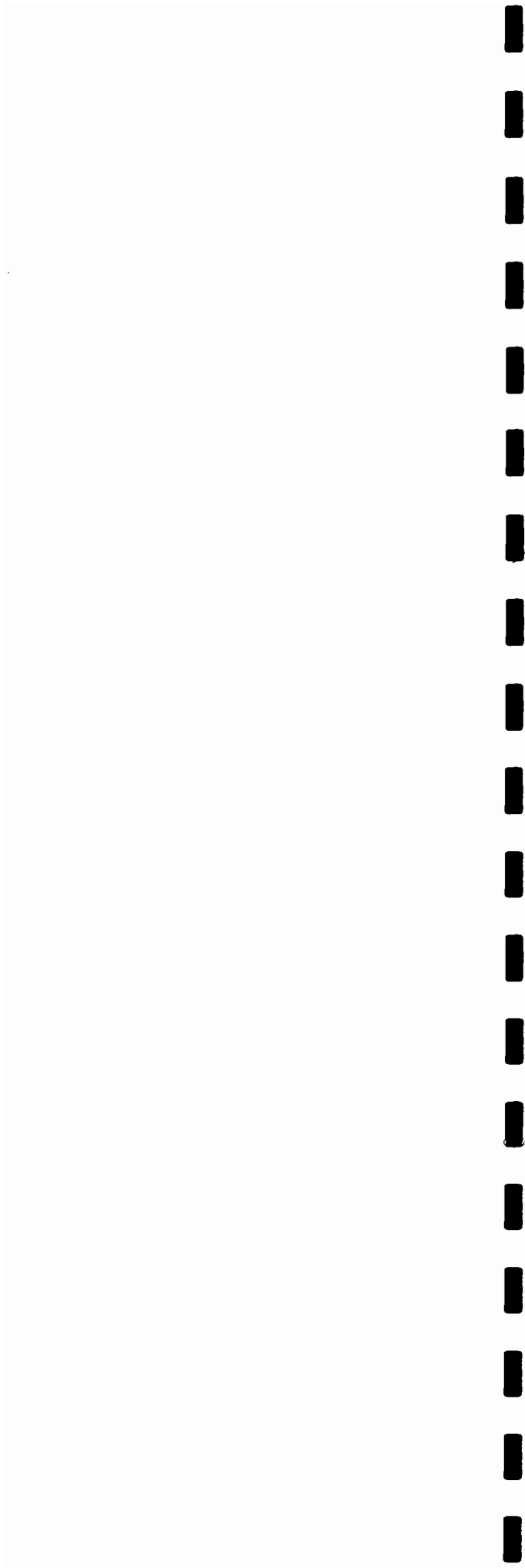
DUNN GEOSCIENCE CORPORATION

AR360356



Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-5B	
Client : NGK Metals Corporation						Sheet 1 of 3	
Purpose : Monitoring Well Installation						Job No. 3943-5-5756	
Drilling Contractor : Eichelberger				Driller : Funk/Knaub		Total Depth 175 ft.	
Geologist : J. J. Painter/S. B. Suter				Specifications <small>Type Diameter Hammer Weight lbs.</small>		Date Started 10/3/89	
Time Log: Begin Finish Depth				Casing steel 6"x100' and steel 7"x10" Well open 6" Bore rock 6"		Notes: quartzite gravel fill 37'-10', grout the remaining interval to 97', used drilling foam to 97' to help lift cuttings Date Finished 10/31/89 S.W.L. 26.58 ft. <u>TOC/GL</u> Elevation TOC Surface 329.62 ft. 327.62 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0			0-20'	clay, red mud, boulders, gravel	fill
10					
20			20-23'	shale and clay	severely weathered
			23-25'	medium to dark grey limestone	medium-dark grey
			25-35.5'	fractured zone	water in the fractured zone (no estimate)
30					
			35.5-55'	medium to dark grey limestone with calcite	
40					
50					
			55-60'	limestone, as above, with light brown clay, chert	
60					



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-5B

Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-68' limestone, as above with light brown clay, chert	
70				68-80' weathered limestone, limonite, severely leached	
80				80-90' medium to dark grey limestone	
90				90-97' limestone, as above with light brown clay	
100				97-125' clay/ water filled void	
110					
120				125-140' medium to dark grey limestone	
130					
140					

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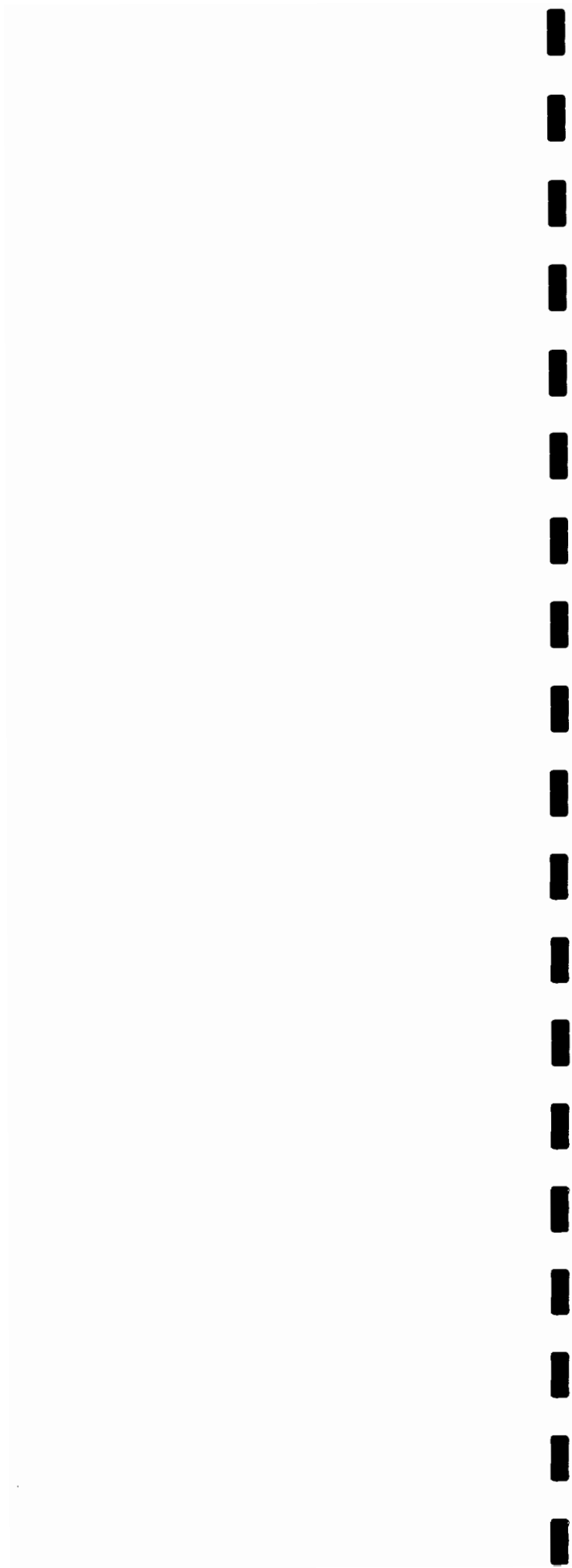


Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : RFI						Boring No. MW-6A	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 51 ft.	
Geologist : J. J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 8/30/89	
Time Log: Begin Finish Depth				Casing steel 6"x22'		Notes: 4 in. pvc .02 slot screen with polyester wrap from 51'-31', #1 morie sand and formation gravel	
				Bore rock/uncons. 6"		S.W.L. 33.91 ft. <u>TOC/GL</u>	
				Well pvc 4"		Elevation TOC Surface	
				Sampler		327.99 ft. 326.04 ft.	
				51'-22.5', bentonite			
				22.5'-21.5', grout to 0'			

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
10				0-1' gravel, rock, silt (fill)	wet @ 8'
				1-5' brown to reddish brown clay and silt	
				5-7' dark brown silt (fill)	
				7-11' lt. brown to brown clay sand, quartzite gravel	
				11-12' as above with very coarse gravel	
20				12-17' reddish brown clay, sand, and fine gravel	used water and foam to return cuttings
				17-22' clay, as above with coarse gravel	
				22-25' reddish brown clay, sandy	
				25-27' clay, as above with coarse gravel	
				27-41' clay as above, coarse sand to fine gravel	
40				41-42' weathered broken dolomite	45-46' broken zone, water flow increased
				42-51' medium to dark gray dolomite, trace weathered (iron stained) shale	
				45-46'	
50				51' fractured zone, mud filled	final flow is ~5 gpm.
60					

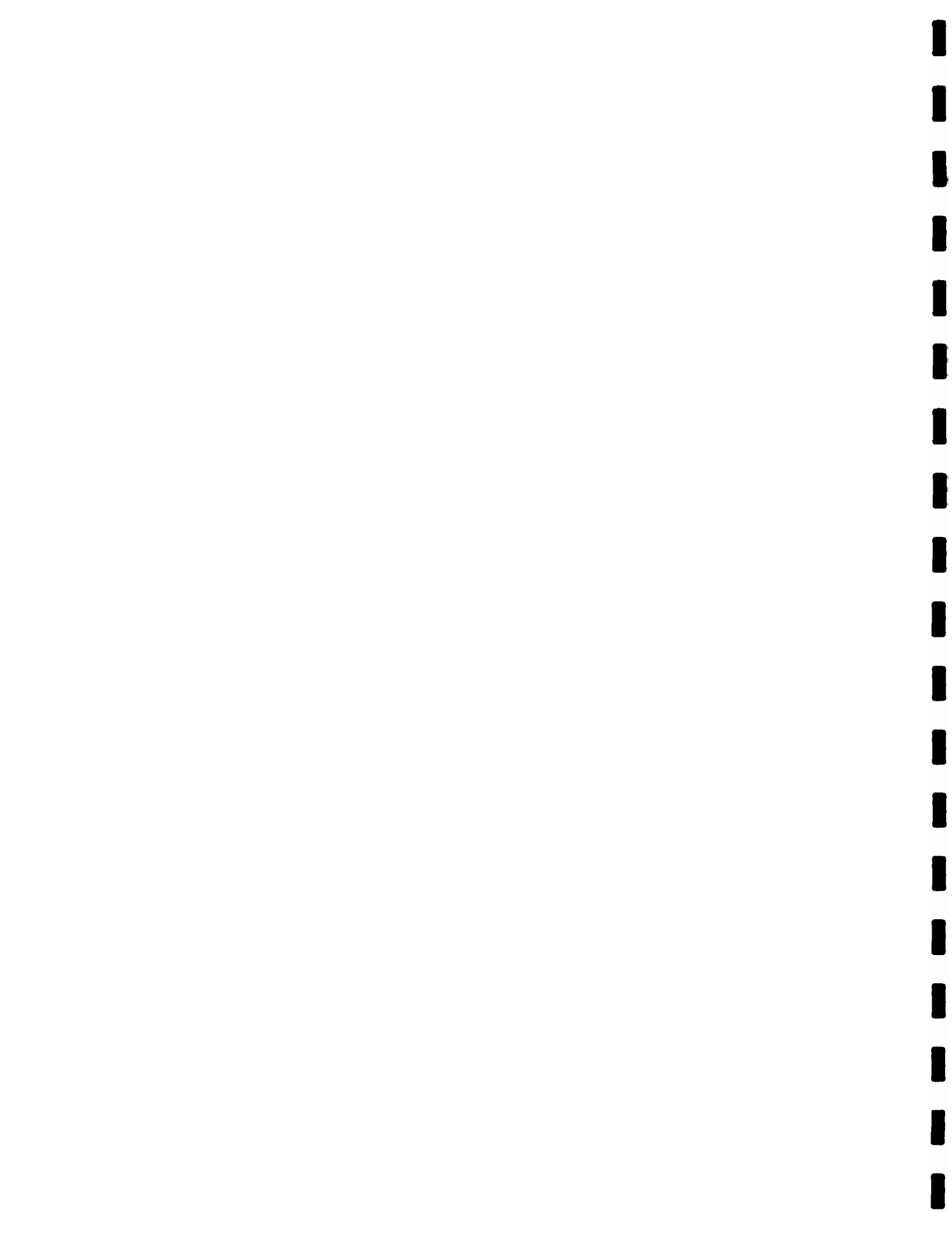
DUNN GEOSCIENCE CORPORATION

AR360360



Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : RFI						Boring No. MW-7A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 75 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter</small>		Hammer <small>Weight lbs.</small>	
Time Log: Begin Finish Depth				Casing steel 6" x 21'		Notes: 4" pvc .02 slot screen with polyester wrap 68'-48', #1 morie sand and formation gravel 68'-33', bentonite 33'-32', grout 32'-0'	
Date Started 9/11/89				Bore rock/uncons 6"		Date Finished 9/11/89	
Well pvc 4"				Sampler		S.W.L. 41.18 ft. <u>TOC/GL</u>	
Elevation TOC Surface				320.71 ft. 318.95 ft.		32'-0'	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-5'			[Pattern: Dotted]	gravel and soil fill	damp
5-8'			[Pattern: Dotted]	reddish brown clay, gravel, and sand	
8-60'			[Pattern: Dotted]	light brown to brown silt, sand, gravel, and clay	
10			[Pattern: Dotted]		31' used water and foam to help return cuttings
11			[Pattern: Dotted]		
12			[Pattern: Dotted]		
13			[Pattern: Dotted]		
14			[Pattern: Dotted]		
15			[Pattern: Dotted]		
16			[Pattern: Dotted]		
17			[Pattern: Dotted]		
18			[Pattern: Dotted]		
19			[Pattern: Dotted]		
20			[Pattern: Dotted]		
21			[Pattern: Dotted]		
22			[Pattern: Dotted]		
23			[Pattern: Dotted]		
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27			[Pattern: Dotted]		
28			[Pattern: Dotted]		
29			[Pattern: Dotted]		
30			[Pattern: Dotted]		
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32			[Pattern: Dotted]		
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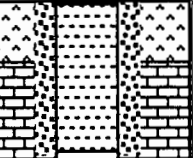
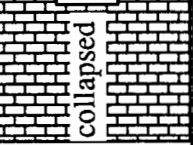
Test Boring/Well Construction

Project : RFI

Boring No MW-7A

Client : NGK Metals Corporation

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-63' clay and gravel as above	damp
				63-64' weathered limestone, iron stained	
				64-70' medium gray limestone, oolitic	
70				70-75' medium to dark grey limestone, trace brown sandy layer	final flow is ~2 gpm
80					

Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : RFI						Boring No. MW-8A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 61 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter Hammer Weight lbs.</small>		Date Started 8/29/89	
Time Log: Begin Finish Depth				Casing steel 6" x 21'		Notes: 4" pvc .02 slot screen 57'-37', #1	
Bore				rock/uncons 6"		morie sand 57'-34.5',	
Well				pvc 4"		bentonite 34.5'-34',	
Sampler				grout 34'-0'		Date Finished 9/29/89	
S.W.L. 36.08 ft.				TOC/GL		Elevation TOC Surface	
304.71 ft.				303.23 ft.		304.71 ft. 303.23 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-2'			dark brown topsoil with brick		
2-9'			brown to reddish brown clay, sand and small quartzite gravel		
9-11'			reddish brown sandy clay		moist to wet
11-14'			clay, as above, with large quartzite gravel		
14-17'			very coarse gravel, broken limestone		
17-38'			same as 11-14'		
38-41'			medium to dark gray limestone, broken		
41-48'			medium to dark gray limestone, dolomite appears in this interval		
48-53'			void/weathered zone leached carbonate		
53-60'			medium to dark gray dolomite with thin light to medium gray limestone laminae, weathered to fresh.		
60			collapsed		





Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>											
Project : R F I						Boring No. MW-8B									
Client : NGK Metals Corporation						Sheet 1 of 3									
Purpose : Monitoring Well Installation						Job No. 3943-5-5756									
Drilling Contractor : Eichelberger				Driller :		Total Depth 151 ft.									
Geologist : J. J. Painter				Specifications		Date Started 10/24/89									
Time Log: Begin Finish Depth				<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%;">Type</th> <th style="width: 20%;">Diameter</th> <th style="width: 20%;">Hammer Weight</th> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>		Type	Diameter	Hammer Weight				Notes: used foam to 40' to help lift cuttings		Date Finished 10/25/89	
Type	Diameter	Hammer Weight													
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> </tr> </table>										and steel 10"x56'		S.W.L. 36.48 ft. <u>TOC/GL</u>			
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> </tr> </table>										Well open 6"		Elevation TOC Surface			
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> <td style="width: 20%;"> </td> </tr> </table>										Bore rock 6"		304.58 ft. 303.43 ft.			

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
<div style="margin-top: 10px;">10</div> <div style="margin-top: 10px;">20</div> <div style="margin-top: 10px;">30</div> <div style="margin-top: 10px;">40</div> <div style="margin-top: 10px;">50</div> <div style="margin-top: 10px;">60</div>			<div style="margin-top: 10px;">0-32'</div> <div style="margin-top: 10px;">32-40'</div> <div style="margin-top: 10px;">40-50'</div> <div style="margin-top: 10px;">50-56'</div> <div style="margin-top: 10px;">56-60'</div>	<div style="margin-top: 10px;">sand, gravel and clay,</div> <div style="margin-top: 10px;">severely weathered carbonate rock</div> <div style="margin-top: 10px;">broken carbonate rock, excessive water</div> <div style="margin-top: 10px;">med to dark grey limestone, quartz healed, calcite veins</div> <div style="margin-top: 10px;">med to dark grey limestone, competent, calcite veinlets</div>	major fractured zone, water < 50 gpm



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-8B

Client : NGK Metals Corporation

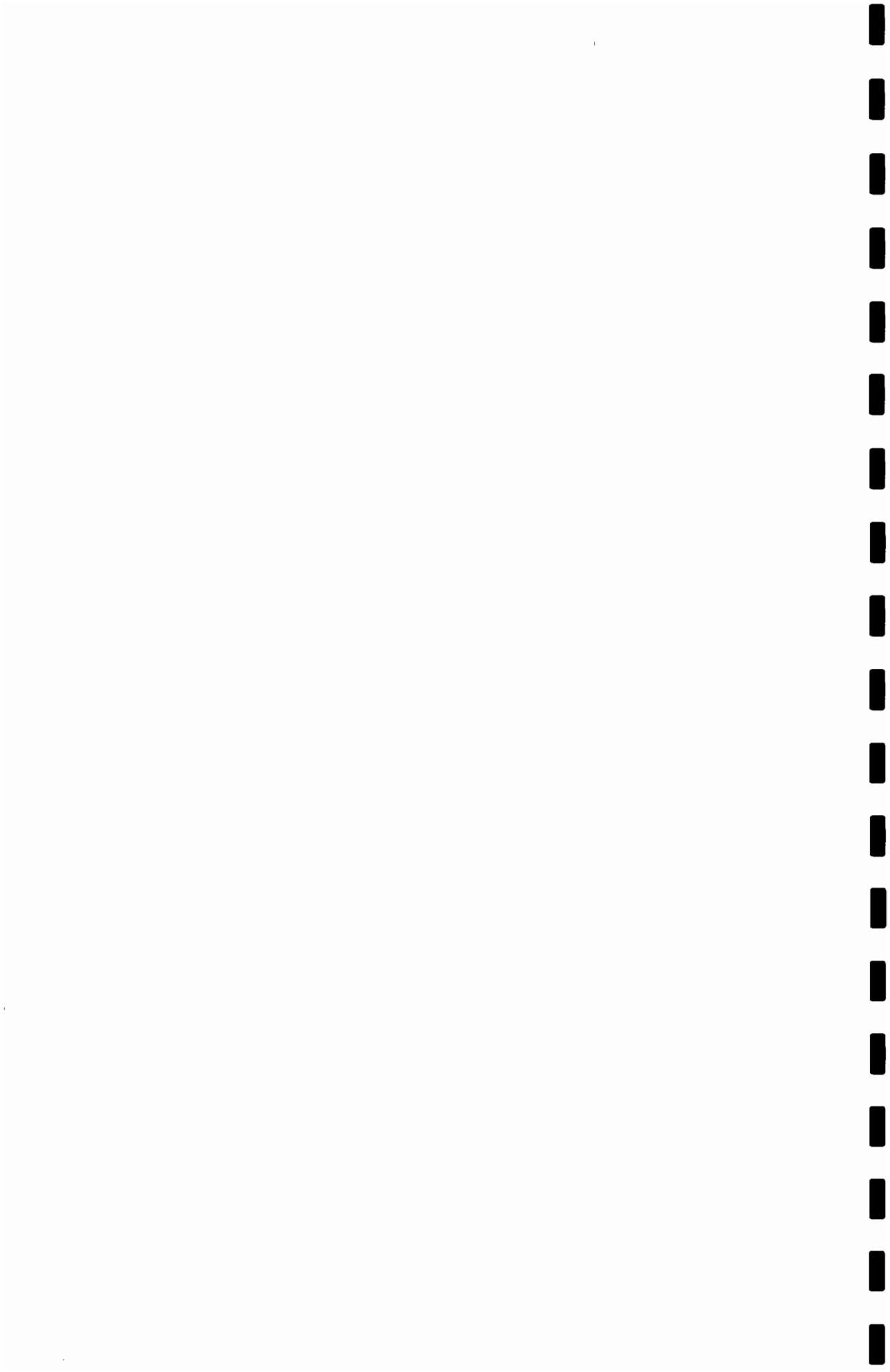
Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-126' medium to dark grey limestone, more competent, calcite veinlets	
70					
80					
90					
100					
110					
120					
130				126-140' medium to dark grey dolomite, softer, trace iron staining	
140					

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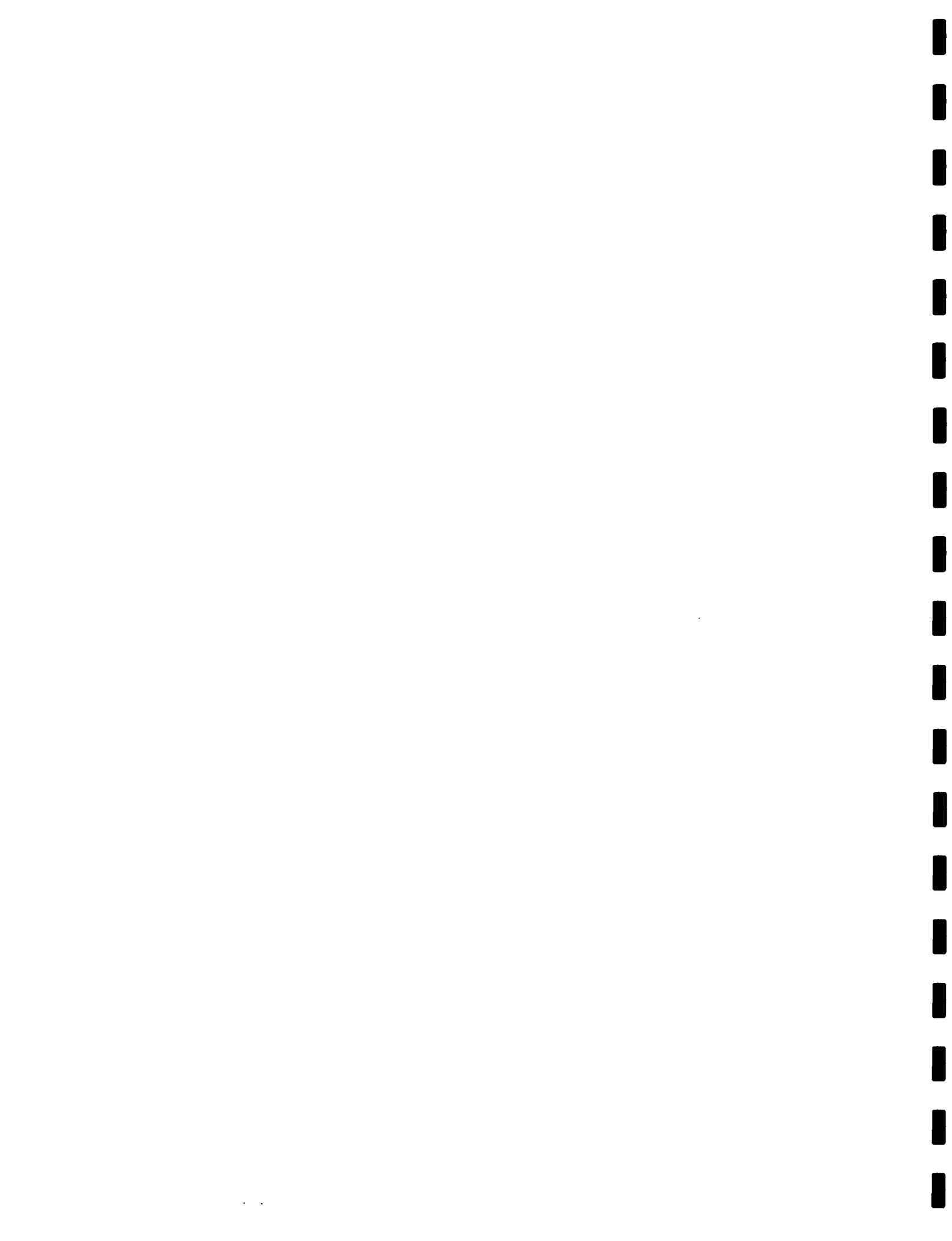
AR360366





Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : RFI						Boring No. MW-9A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K Weigle		Total Depth 75 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter Hammer Weight lbs.</small>		Date Started 9/7/89	
Time Log: Begin Finish Depth				Casing steel 6" x 62'		Notes:	
Bore rock 6"				Well open 6"		Date Finished 9/7/89	
Sampler				S.W.L. 27.28 ft. <u>TOC/GL</u>		Elevation TOC Surface	
333.22 ft.				333.22 ft.		Surface	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1'			0-1'	dark brown topsoil	7.35 ft. of 6" steel casing added 3/93
1-9'			1-9'	red mud	
9-35'			9-35'	coarse gravel and small boulders, wood at 10', trace cinder material, fining downward with increasing clay content	wet @ 9' used water and foam @ 11'
35-37'			35-37'	coarse gravel and sand	
37-55'			37-55'	coarse gravel, clay and small boulders	
55-60'			55-60'	medium to dark grey limestone	







Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-9B

Client : NGK Metals Corporation

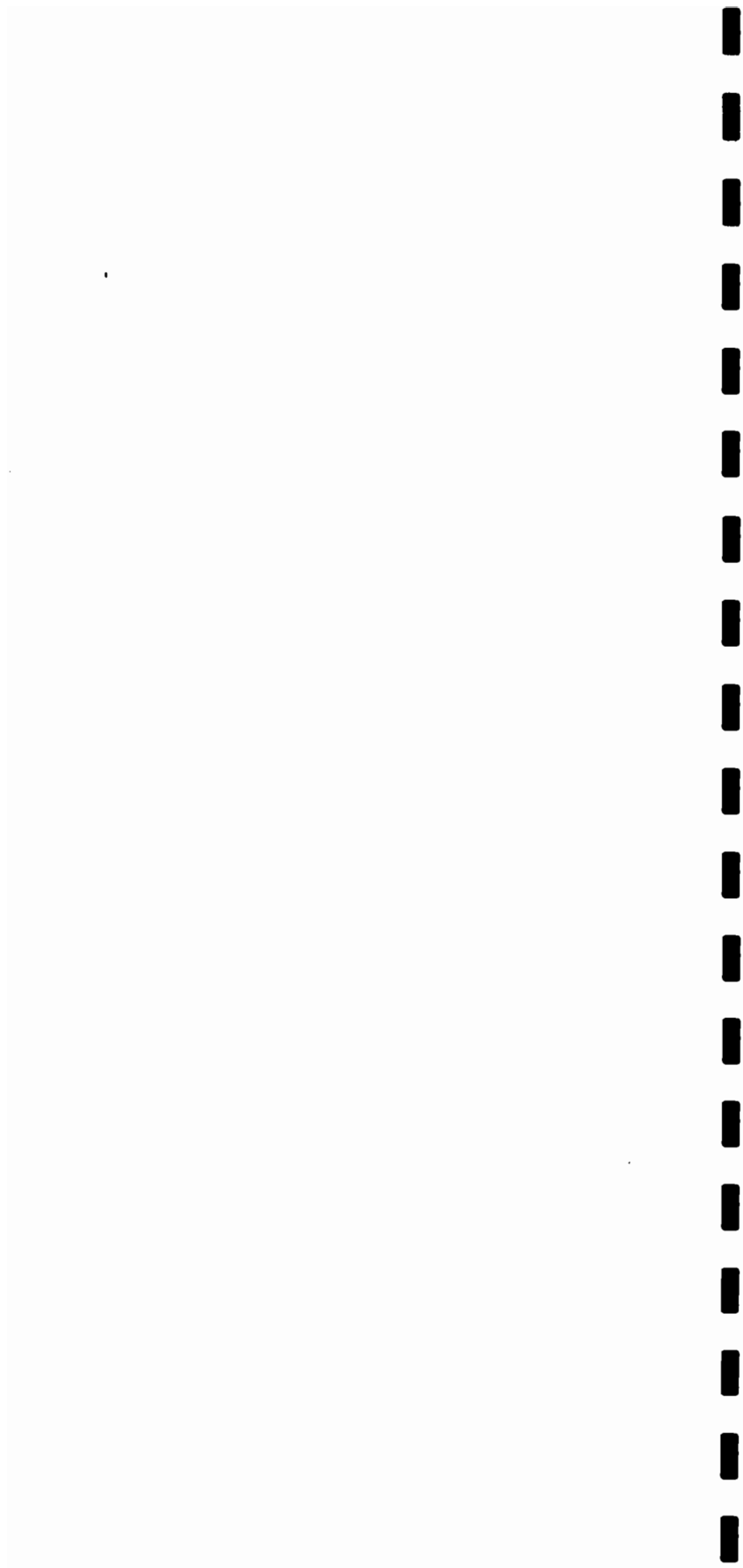
Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-84' medium to dark grey limestone, calcite, fractured	
70					
80					
90				84-86' clay filled void 86-118' severely fractured limestone	
100					
110					
120				118-124.5' medium to dark grey limestone	
130				124.5-125' fractured zone 125-140' medium to dark grey limestone	
140					

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AR360371





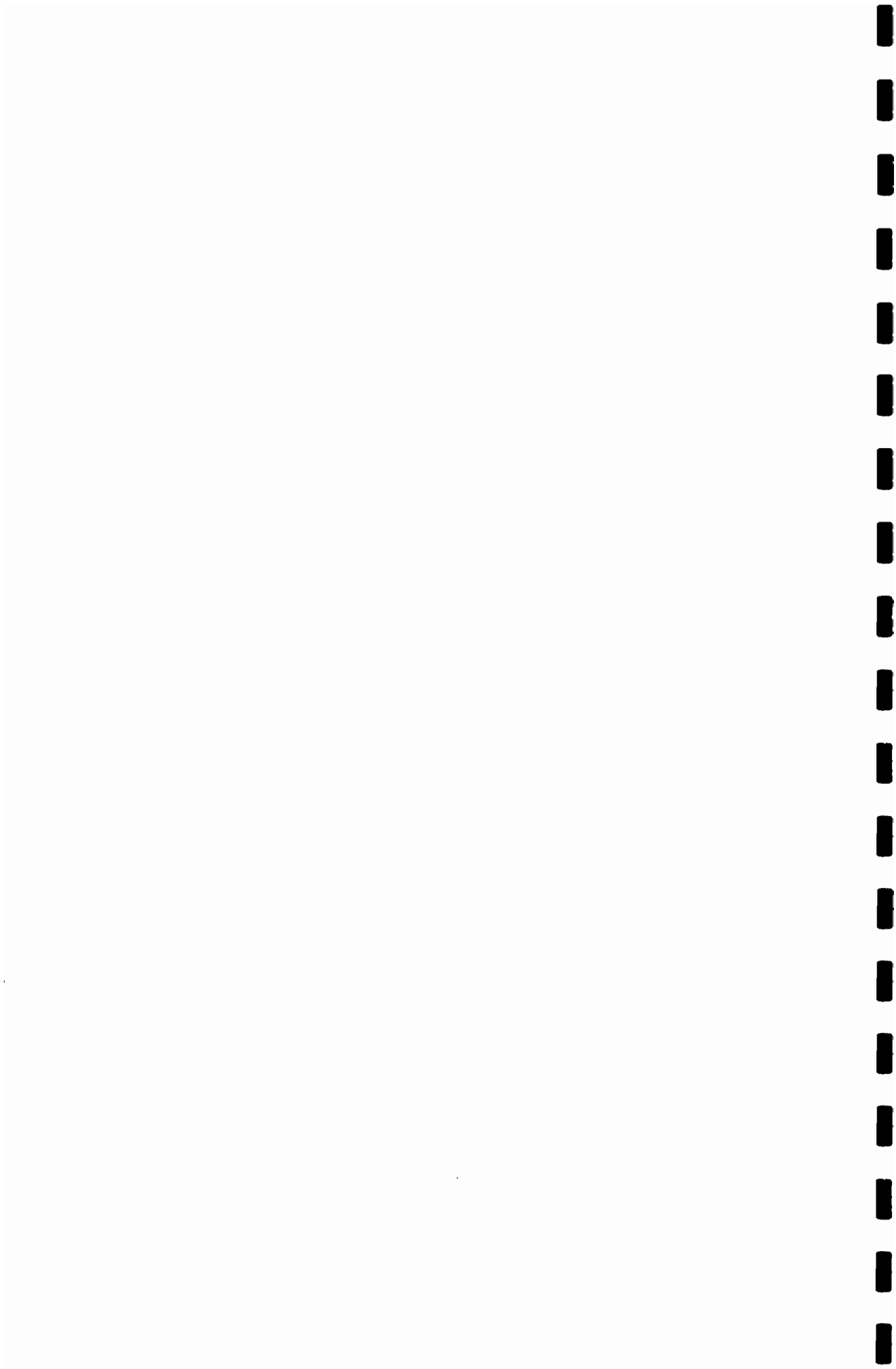
Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-10A	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 51 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter Hammer Weight lbs.</small>		Date Started 10/11/89	
Time Log: Begin Finish Depth				Casing steel 6" x 23'		Notes: 4" pvc .02 slot screen with polyester wrap 41'-21', #1 morie sand and formation gravel 41'-21', bentonite 21'-20', grout 20'-0'	
Bore				rock/uncons 10"		Date Finished 10/12/89	
Well				pvc 4"		S.W.L. 20.06 ft. <u>TOC/GL</u>	
Sampler				20'-0'		Elevation TOC Surface 312.80 ft. 311.50 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-6'			boulders		damp @ 8'
6-21'			very coarse gravel, small boulders, and sand		
21-41'			red clay, sand, and gravel		
41'			dark gray limestone ledge		10" cable tool bit hanging up final flow is ~3 gpm



Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-10B	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : Funk/Knaub		Total Depth 123 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter Hammer Weight lbs.</small>		Date Started 10/11/89	
Time Log: Begin Finish Depth				Casing steel 6" x 94'		Notes: 10" steel casing installed to 35'	
and				steel 10" x 35'		with cable tool, 10" hammer bit to 92',	
Well				open 6"		6" hammer bit to 123	
Bore				rock 6"		quartzite gravel fill 50'-17'	
Date Finished 11/1/89						S.W.L. 18.47 ft. <u>TOC/GL</u>	
Elevation TOC Surface						313.15 ft. 311.90 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-0.5'			0-0.5'	dark brown topsoil	
0.5-2'			0.5-2'	orange brown clay	
2-6'			2-6'	boulder	
6-21'			6-21'	very coarse gravel, sand, small boulders	
21-35'			21-35'	red clay, sand, and gravel	
35-41'			35-41'	brown to olive grey severely weathered limestone	
41-60'			41-60'	medium to dark grey limestone, trace amounts of chert fragments, occasional weathered shale fragments	



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-10B

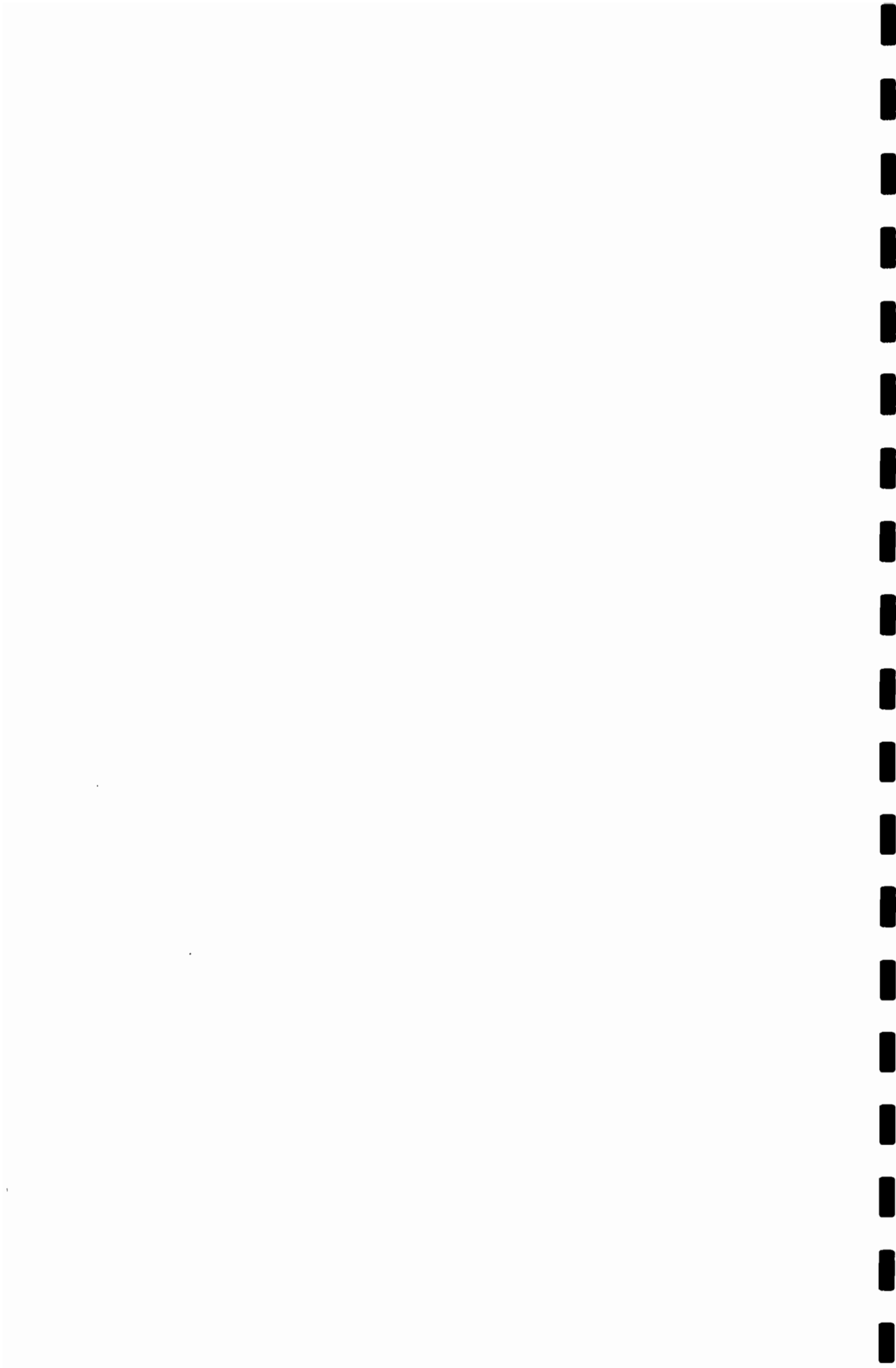
Client : NGK Metals Corporation

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-104' medium to dark grey limestone, trace amount of chert fragments, occasional weathered shale fragments	
70					
80					
90					
100					
104				104-106' mud/water filled crack, rock not very broken	
105				104-115' medium to dark grey limestone, more competent rock	
110					
115				115-123' mud/water filled void with broken limestone	
120					final flow is ~10 gpm
130					

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Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-11A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 3943-5-5756	
Drilling Contractor : Eichelberger				Driller : Funk/Knaub		Total Depth 73 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter</small>		Hammer <small>Weight lbs.</small>	
Time Log: Begin Finish Depth				Casing steel 8"x11'		Notes:	
_____				and steel 6"x20'		Date Started 10/30/89	
_____				Well open 6"		S.W.L. 29.35 ft. <u>TOC/GL</u>	
_____				Bore rock 6"		Elevation TOC Surface	
_____				_____		330.0 ft. 328.0 ft.	

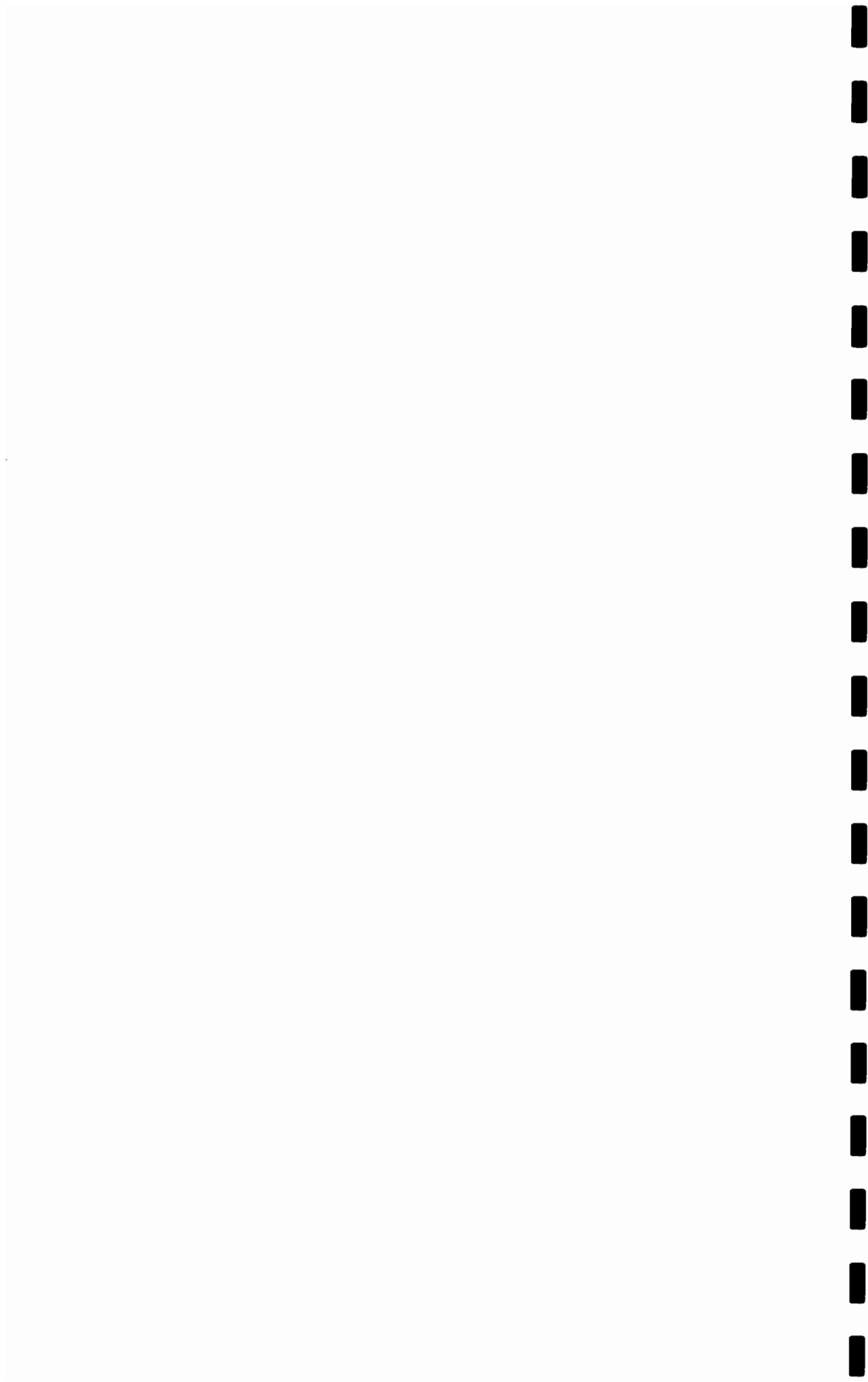
Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
10			0-11'	overburden, fill, consisting of clay, silt, sand, wood and brick	
20			11-33'	medium to dark grey limestone	
30			33-34'	broken zone, weathered medium to dark grey limestone, trace dolomite	
40			34-60'		
50					
60					







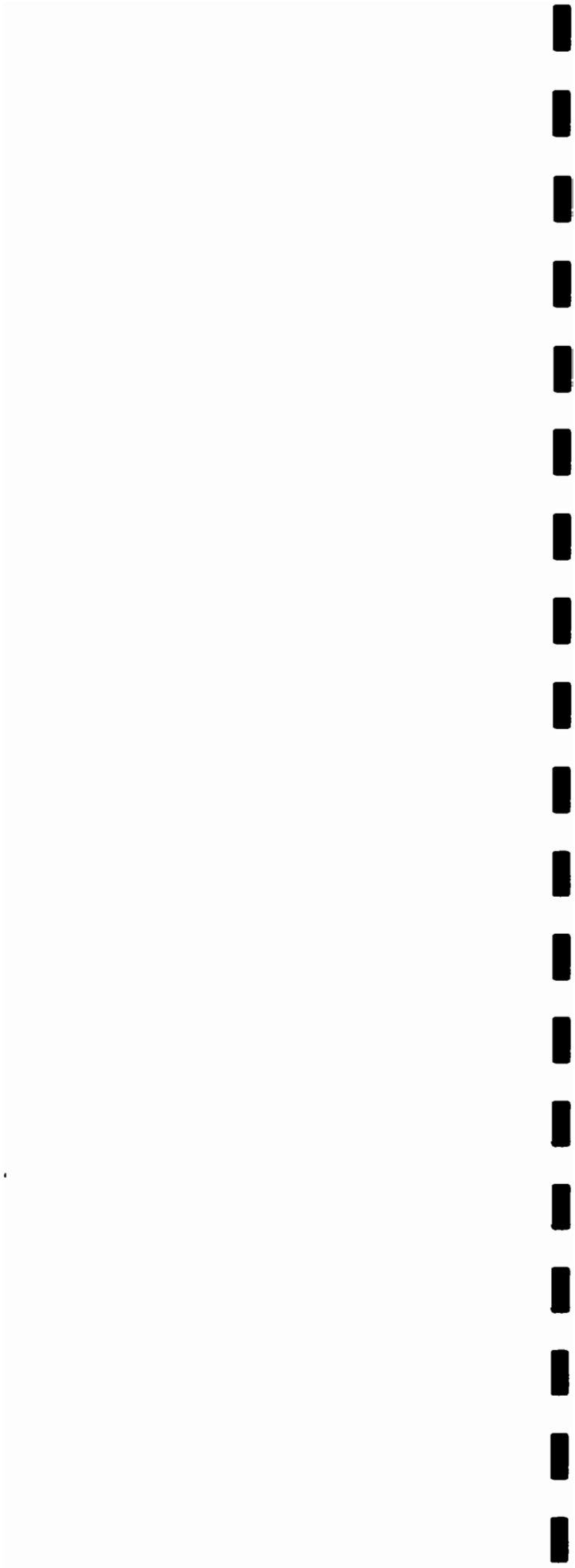


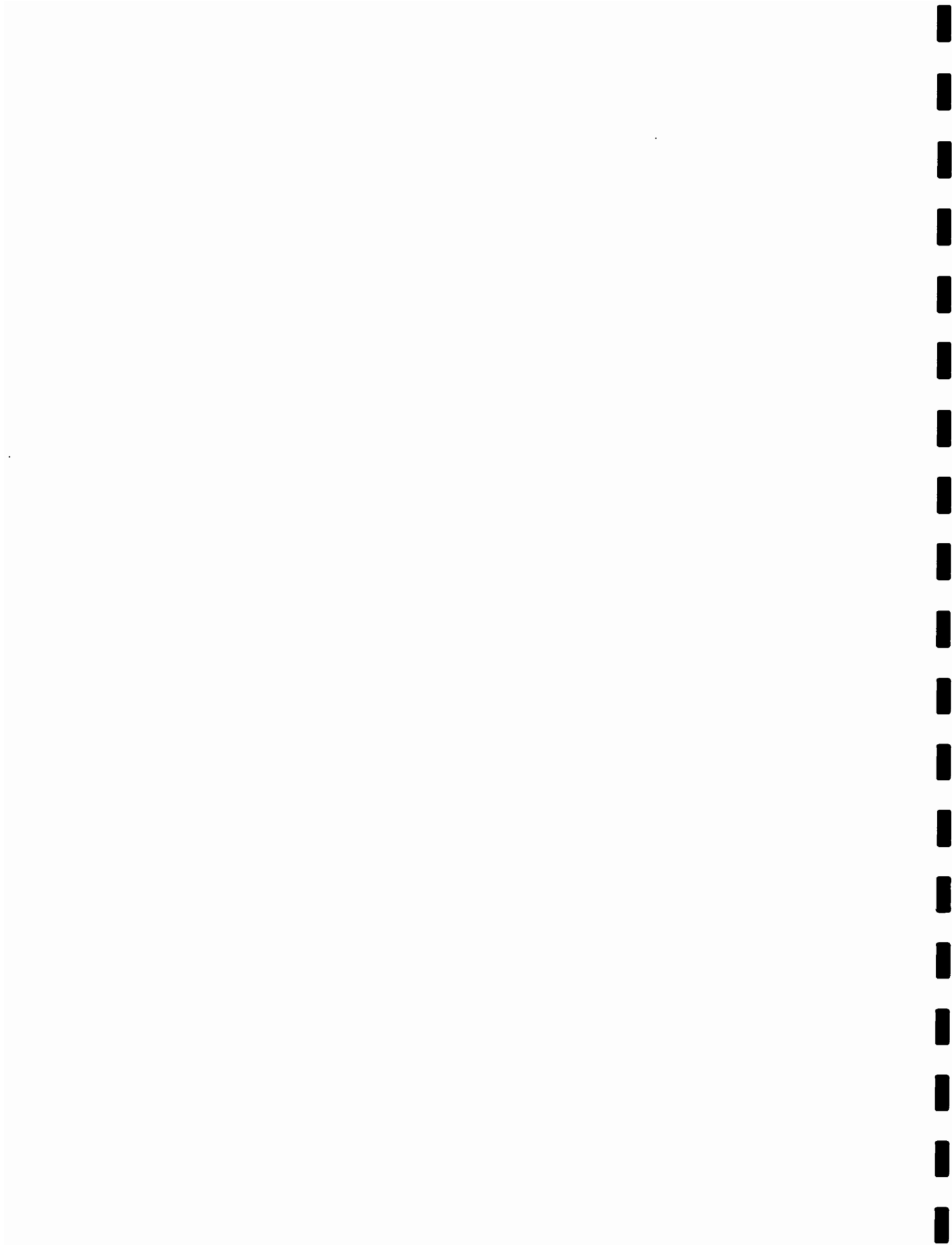
Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-12A	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : E. Funk		Total Depth 60 ft.	
Geologist : J. J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 9/29/89	
Time Log: Begin Finish Depth				Casing steel 6"x12"		Notes: 4" pvc .02 slot screen with polyester wrap 55'-35', #1 morie sand and formation gravel 55-47', grout 12'-0'	
Date Time Depth				Bore uncons 10"		Date Finished 10/4/89	
Date Time Depth				Well pvc 4"		S.W.L. 22.32 ft. <u>TOC/GL</u>	
Date Time Depth				Sampler		Elevation TOC Surface 311.60 ft. 309.40 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1'			topsoil		
1-35'			light brown sand and gravel, mostly quartzite		
10					moist @ 9'
20					
30					
40					
50					
52'-51'			clay, trace sand, coarse gravel, trace small boulder		
51'-52'			material as above with weathered shale, medium grey limestone fragments and clay		
52'-60'			brown clay, coarse sand, quartzite gravel		
60'			bottom of hole		final flow is ~5 gpm



Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710			Test Boring/Well Construction		
Project : R F I				Boring No. MW-12B	
Client : NGK Metals Corporation				Sheet 3 of 3	
Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
140				140-155' light grey limestone	final flow is ~100 gpm
150					
				155-164' clay filled void, silty, light brown	
160					





Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-13B	
Client : NGK Metals Corporation						Sheet 1 of 3	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : E.Funk/C.Knaub		Total Depth 105 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter Hammer Weight</small>		Date Started 10/5/89	
Time Log: Begin Finish Depth				Casing steel 105x6"		Notes:	
and steel 42x10"				Well open 6"		Date Finished 10/24/89	
Bore rock 6"				S.W.L. 35.24 ft. <u>TOC/GL</u>		Elevation TOC Surface	
304.45 ft.				301.83 ft.		301.83 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-5'			0-5'	brown silty soil with sand	
5-18'			5-18'	small boulder, coarse gravel, sand	
10					
18-40'			18-40'	gravel coarse sand, clayey	
20					
30					
40-41'			40-41'	olive grey limestone, weathered	
41-49'			41-49'	medium dark grey limestone	
49-53'			49-53'	intermittent zones of dolomite, brown to olive brown shale	
53-55'			53-55'	competent rock, dark grey dolomite	
55-60'			55-60'	medium dark grey limestone	
60					some gravel and clay filled pockets w/water



Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : R F I						Boring No. MW-12B	
Client : NGK Metals Corporation						Sheet 1 of 3	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : E. Funk/ Knaub		Total Depth 160 ft.	
Geologist : J. J. Painter/S. B. Suter				Specifications <small>Type Diameter</small>		Hammer Weight: lbs.	
Time Log: Begin Finish Depth				Casing steel 100' x 6"		Notes:	
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>				arnd steel 27' x 10"		Date Started 10/4/89	
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>				Well open 6"		Date Finished 10/27/89	
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>				Bore rock 6"		S.W.L. 24.86 ft. <u>TOC/GL</u>	
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>				<div style="border: 1px solid black; height: 20px; width: 100%;"></div>		Elevation TOC Surface 307.83 ft. 305.90 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
10			0-5'	topsoil, brown clayey	
			5-8'	small boulders	
			8-15'	coarse gravel, sd, clay	
			15-21'	gravel, sand, clay	
20			21-24'	light to dark grey weathered dolomite, trace calcite	
			24-30'	medium to dark grey limestone	
			30-33'	fractured zone, water	
			33-35'	mud filled void	
30			35-60'	medium to dark grey limestone	
40					
50					
60					



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Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

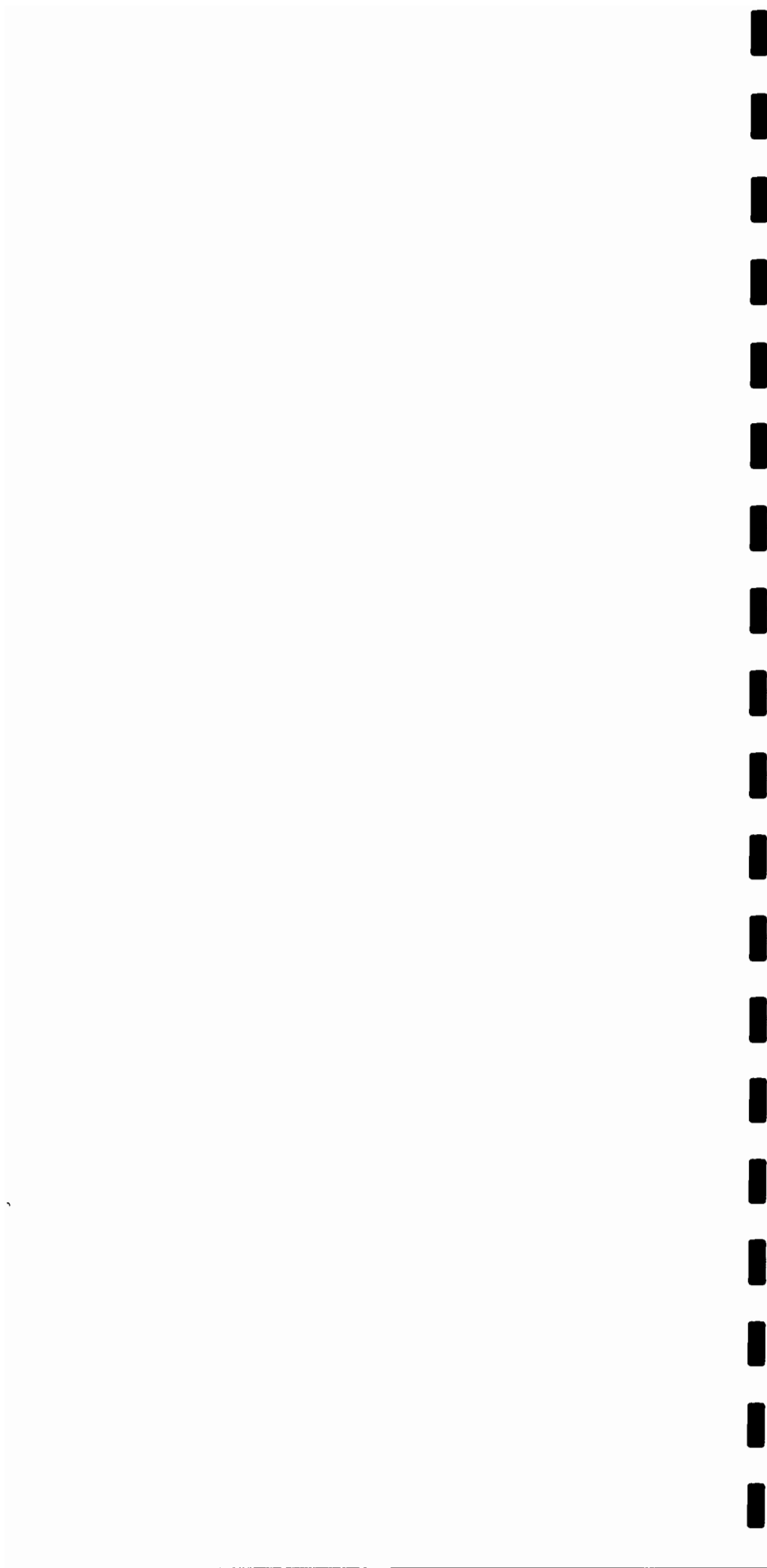
Project : R F I

Boring No. MW-12B

Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-84' medium to dark grey limestone	
70					
80					
84				84-86' fractured zone	
86				86-100' medium to dark grey limestone and dolomite	
90					
100				100-140' light grey limestone	
110					
120					
130					
140					



Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-13B

Client : NGK Metals Corporation

Sheet 3 of 3

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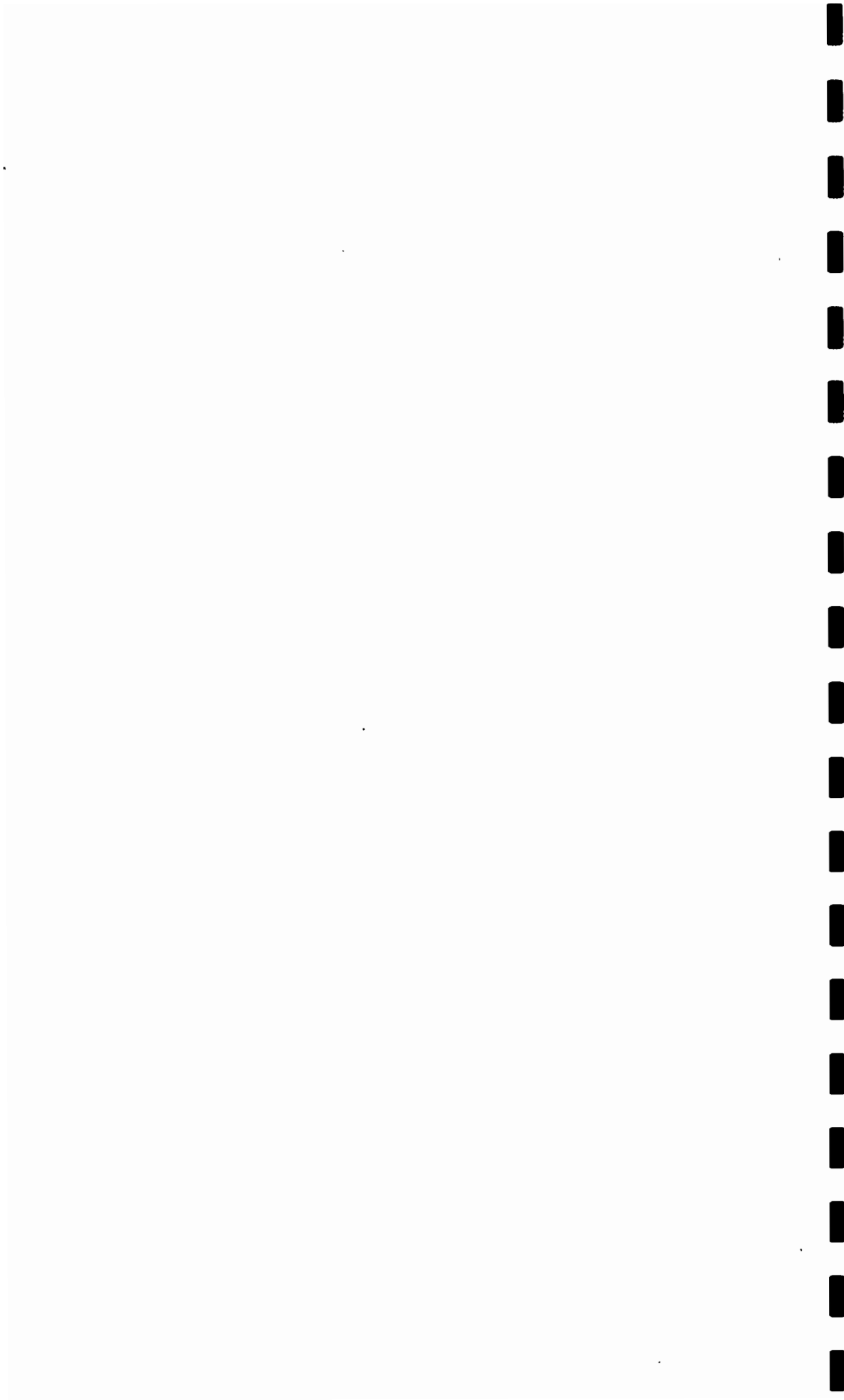


Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				Test Boring/Well Construction Log			
Project : RFI						Boring No. MW-14A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 3943-5-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 76 ft.	
Geologist : J. J. Painter				Specifications		Date Started 9/19/89	
				Type	Diameter	Hammer Weight	lbs.
Time Log: Begin Finish Depth				Casing	steel	11'x 6"	Notes: 4" pvc .02 slot screen 68'-48' with polyester wrap, #1 morie sand 70'-44', bentonite 44'-42', grout 42'-0'.
				Bore	rock/uncons	10"	
				Well	pvc	4"	
				Sampler			
				Date Finished 9/19/89			
				S.W.L. 50.96 ft. TOC/GL			
				Elevation TOC			Surface
				= 327.97 ft.			326.54 ft.

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1'				dark brown topsoil	quartzite gravel
1-10'				brown to orange brown clay, sand, trace brown shale fragments	
10-36'				light brown silt, gravel and small boulders	
36-60'				light brown to orange brown clay with light brown weathered shale	moist

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Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-14A

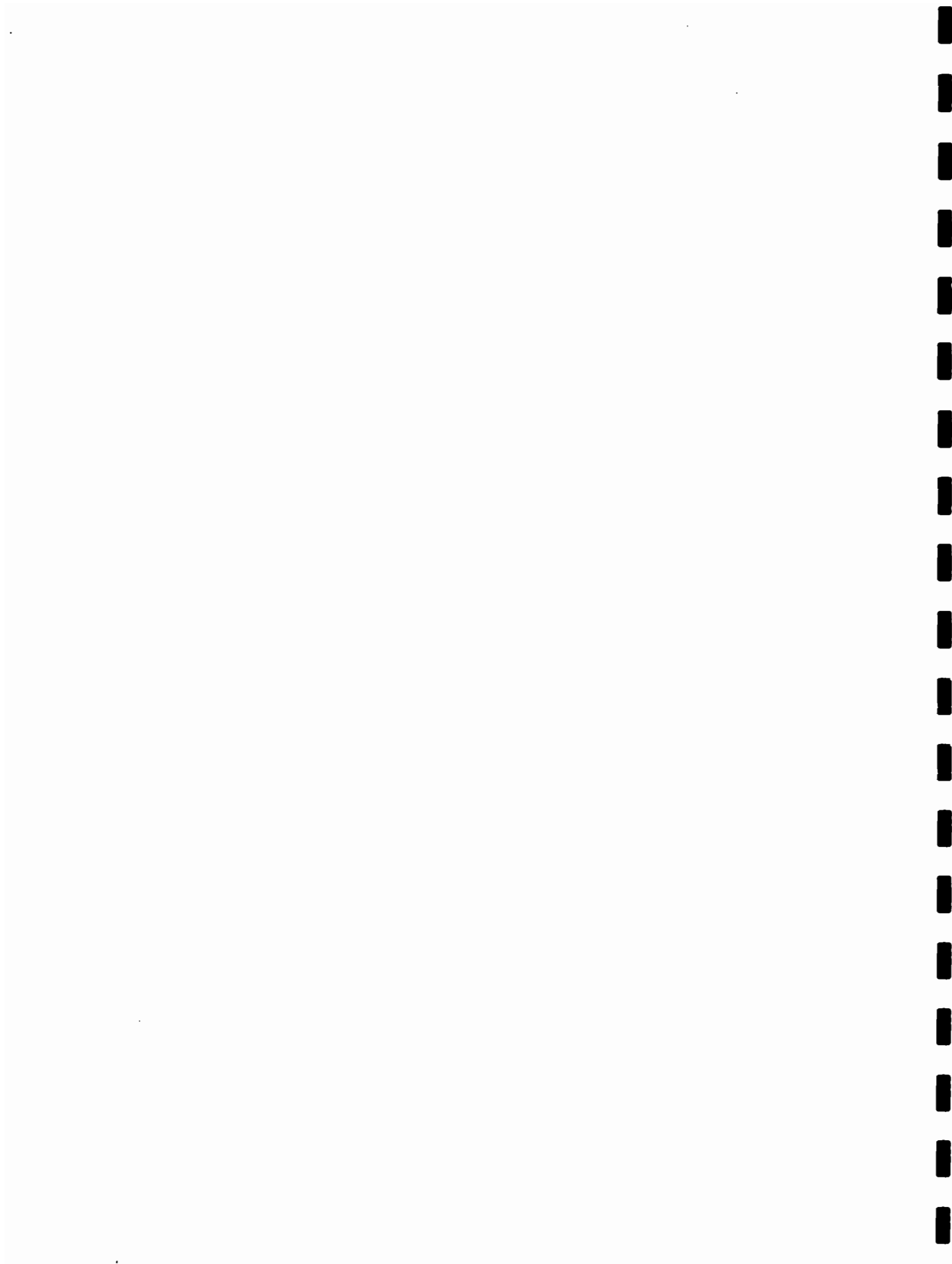
Client : NGK Metals Corporation

Sheet 2 of 2

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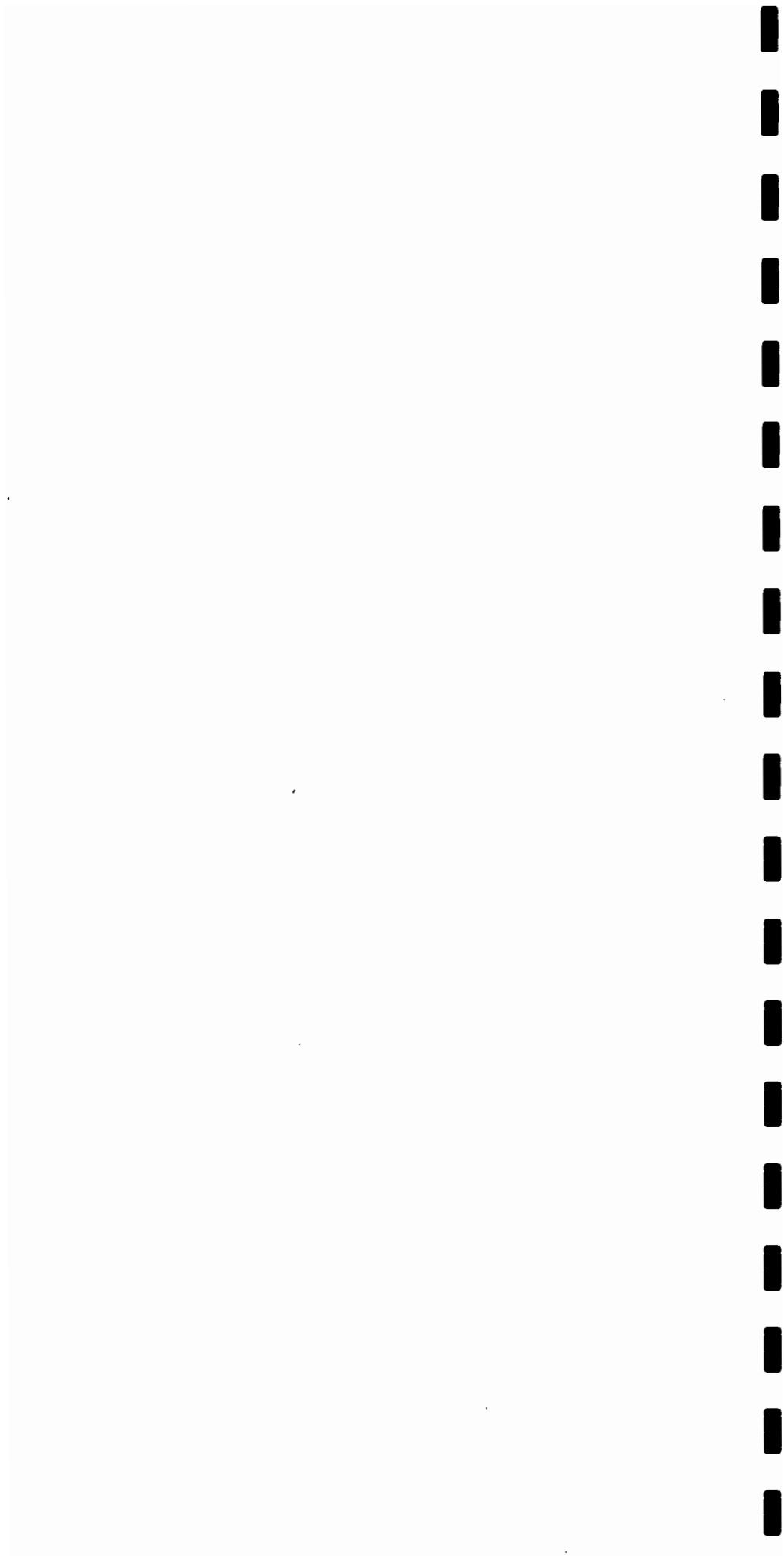


Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : RFI						Boring No. MW-15A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : C. Knaub		Total Depth 68 ft.	
Geologist : J. J. Painter				Specifications <small>Type Diameter</small>		Hammer <small>Weight lbs.</small>	
Time Log: Begin Finish Depth				Casing steel 11"x 6"		Date Started 9/21/89	
Bore rock 10"				Well pvc 4 "		Notes: 4" pvc .02 slot screen 66.5'-46.5', #1 morie sand 66.5'-43', bentonite 43'-42', grout 42'-0	
Sampler				Date Finished 9/21/89		S.W.L. 39.83 ft. <u>TOC/GL</u>	
Elevation TOC Surface				329.56 ft. 327.62 ft.		329.56 ft. 327.62 ft.	







Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-3'			pavement		used foam to 68' to help return cuttings
3-9'			brown clay		
9-14'			broken medium grey limestone, olive grey dolomite, weathered as above, with clay		
14-26'			olive grey shale and dolomite		
26-28'			broken/weathered shale/sandy shale & dolomite		
28-33'			orange brown clay		
33-35'			medium to dark grey limestone		
35-55'					
55-57'			void, brown clay filled		
57-60'			dark grey limestone		
60					

DUNN GEOSCIENCE CORPORATION

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Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>				
Project : R F I						Boring No. MW-15B		
Client : NGK Metals Corporation						Sheet 1 of 3		
Purpose : Monitoring Well Installation						Job No. 37-3943-5756		
Drilling Contractor : Eichelberger				Driller : Knaub		Total Depth 175 ft.		
Geologist : J. J. Painter				Specifications		Date Started 9/22/89		
				Type	Diameter	Hammer Weight	lbs.	
Time Log:	Begin	Finish	Depth	Casing	steel	118"x 6"	Notes:	
				Bore	rock	6"		Date Finished 9/22/89
				Well	open	6"		S.W.L. 50.56 ft. <u>TOC/GL</u>
				Sampler				Elevation TOC Surface 329.63 ft. 327.66 ft.

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-5'				pavement, cinder, gravel	3-5':brown clay
5-10'				med. dark grey limestone	5-6':weathered olive grey dolomite
10-14'				med. dark grey limestone, occasional red shale & sandstone fragments	6-7': calcite laminae
14-35'				broken zone, clay, weathered olive-grey shale and dolomite	7-9':brecciated pink dolomite
35-50'				competent medium dark grey limestone, occasional olive grey weathered shale fragments near top of zone	9-10':yellowish brown dolomite
50-60'				dark grey dolomite and limestone with shale	



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Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-15B

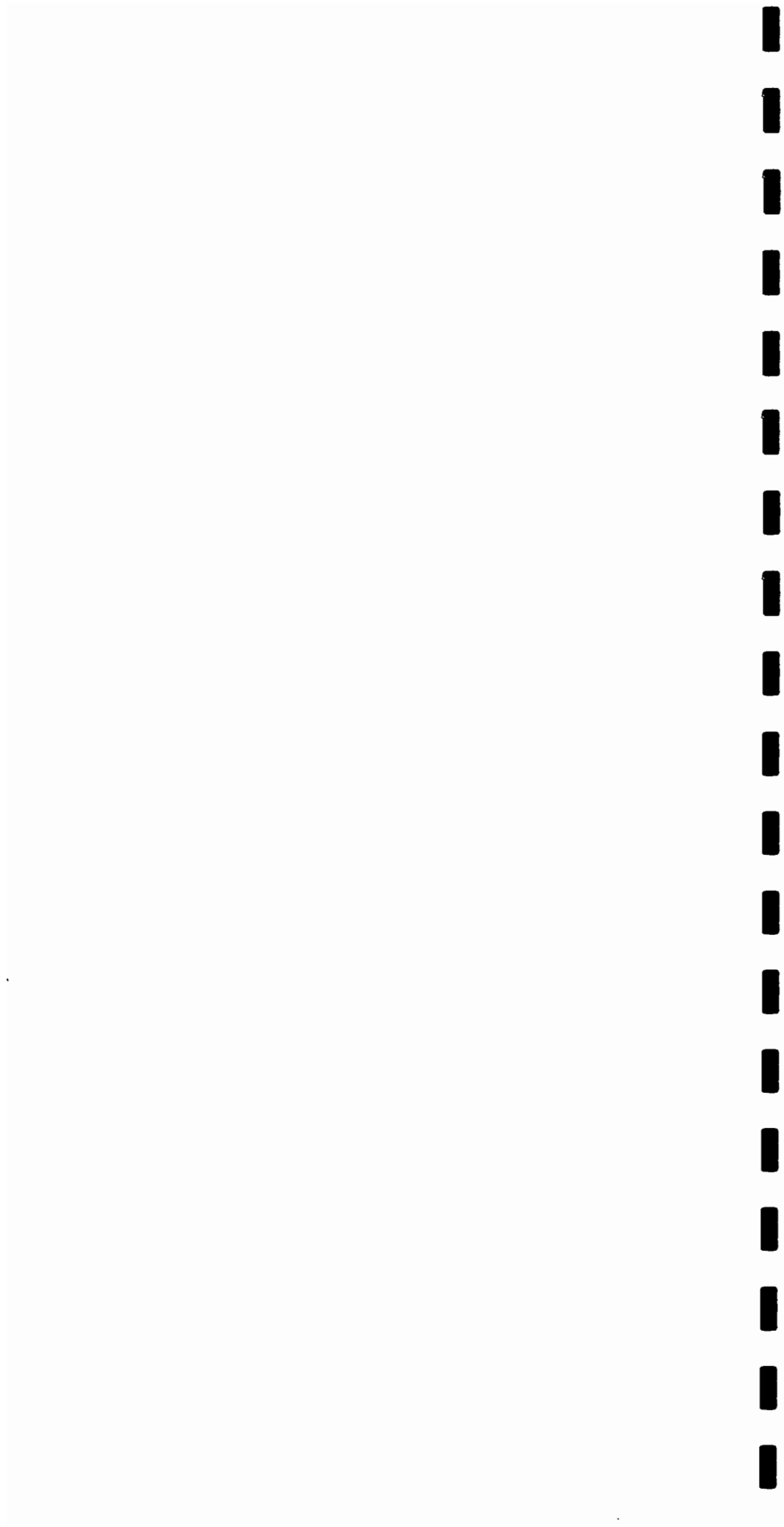
Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-75' dark grey dolomite and limestone with shale	
70					
80				75-82' medium to dark grey limestone, trace weathered dark brown shale	
				82-85' brecciated limestone, quartzite, shale	
				85-140' medium to dark grey limestone, calcite present	trace olive grey dolomite, fractured, water
90					
100					
110					
120					
130					
140					

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Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-15B

Client : NGK Metals Corporation

Sheet 3 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
140				140-147' medium to dark grey limestone, calcite	final estimated flow is <5 gpm
				147-162' light to medium grey limestone with dolomite	
150					
160				162-167' medium to dark grey limestone	
				167-175' light to medium grey limestone with light brown slightly weathered dolomite	
170					
180					

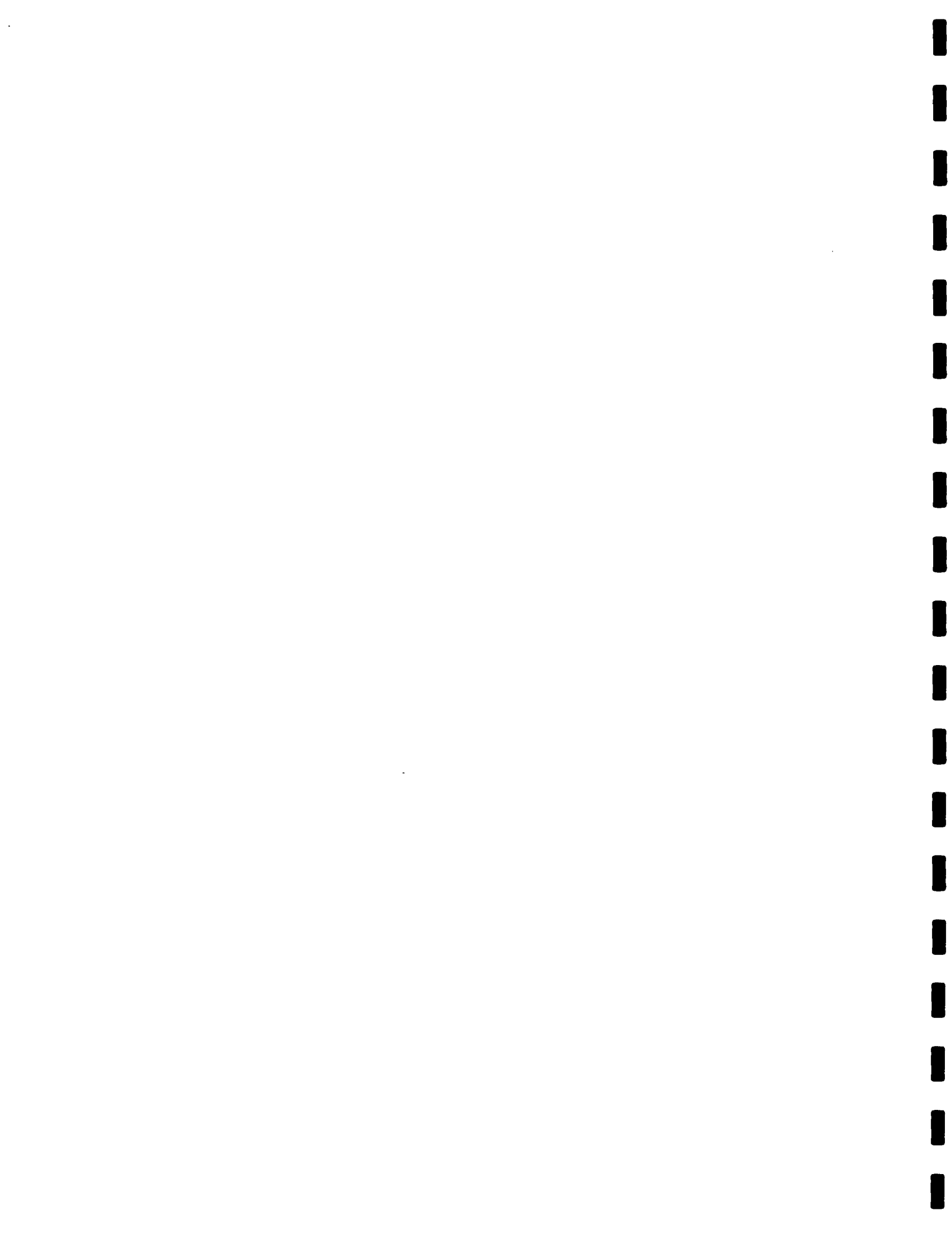
DUNN GEOSCIENCE CORPORATION

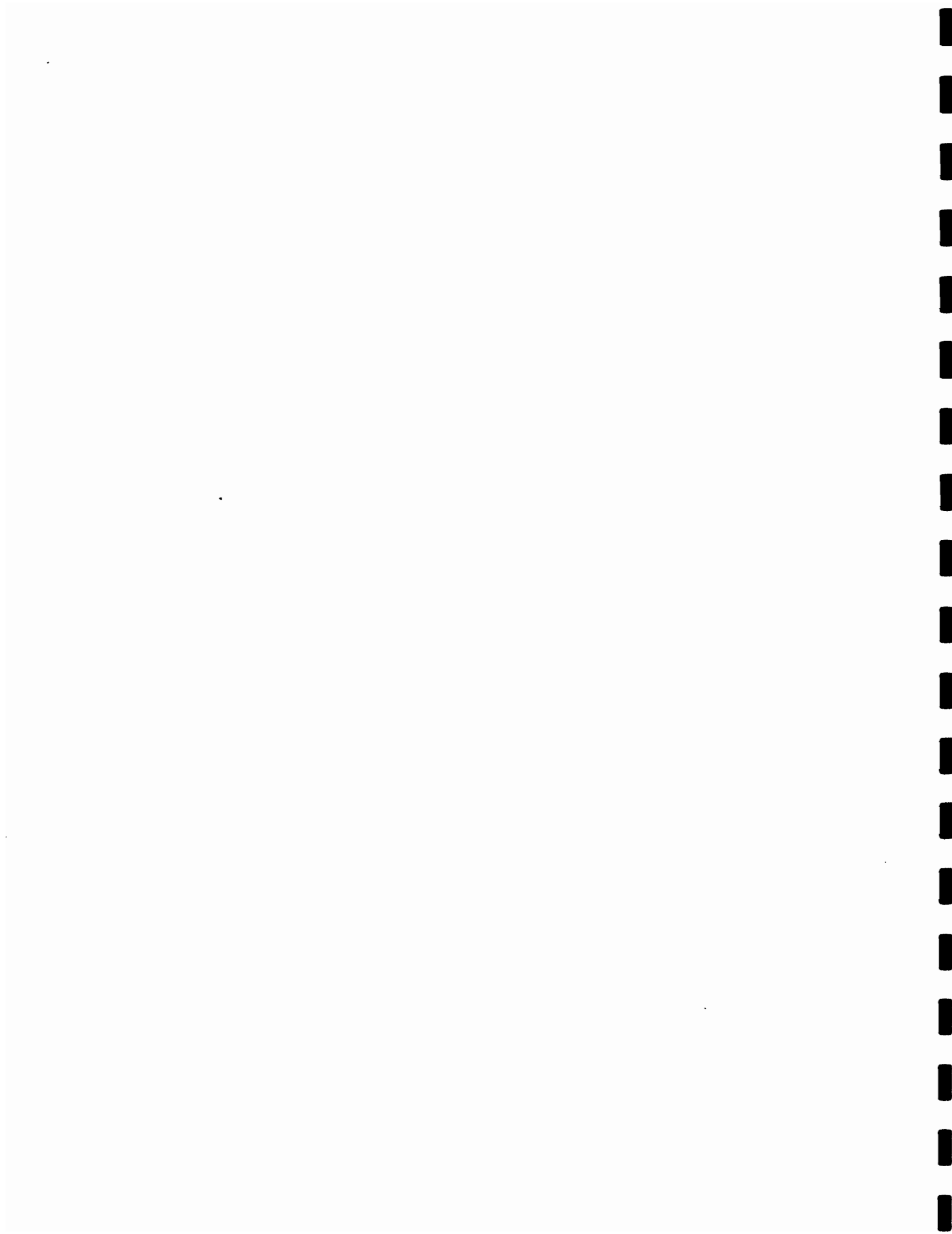
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Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				Test Boring/Well Construction Log			
Project : R F I						Boring No. MW-16A	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 75 ft.	
Geologist : J. J. Painter				Specifications Type Diameter		Hammer Weight lbs.	
Time Log: Begin Finish Depth				Casing steel 12'x 6"		Date Started 9/12/89	
				Bore rock 6"		Date Finished 9/12/89	
				Well open 6"		S.W.L. 52.58 ft. <u>TOC/GL</u>	
				Sampler		Elevation TOC Surface 328.74 ft. 327.27 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-4'				dark brown topsoil	
4-5'				reddish brown clay	
5-7'				broken limestone with calcite filled veins	
7-25'				medium dark grey limestone with medium grey to olive grey dolomite, intermittent thin beds of olive brown to grey shale	
25-31'				softer zone, broken, trace brown sandy chips	cuttings are larger
31-60'				medium to dark grey limestone	no visual signs of increased water flow in addition to drill water



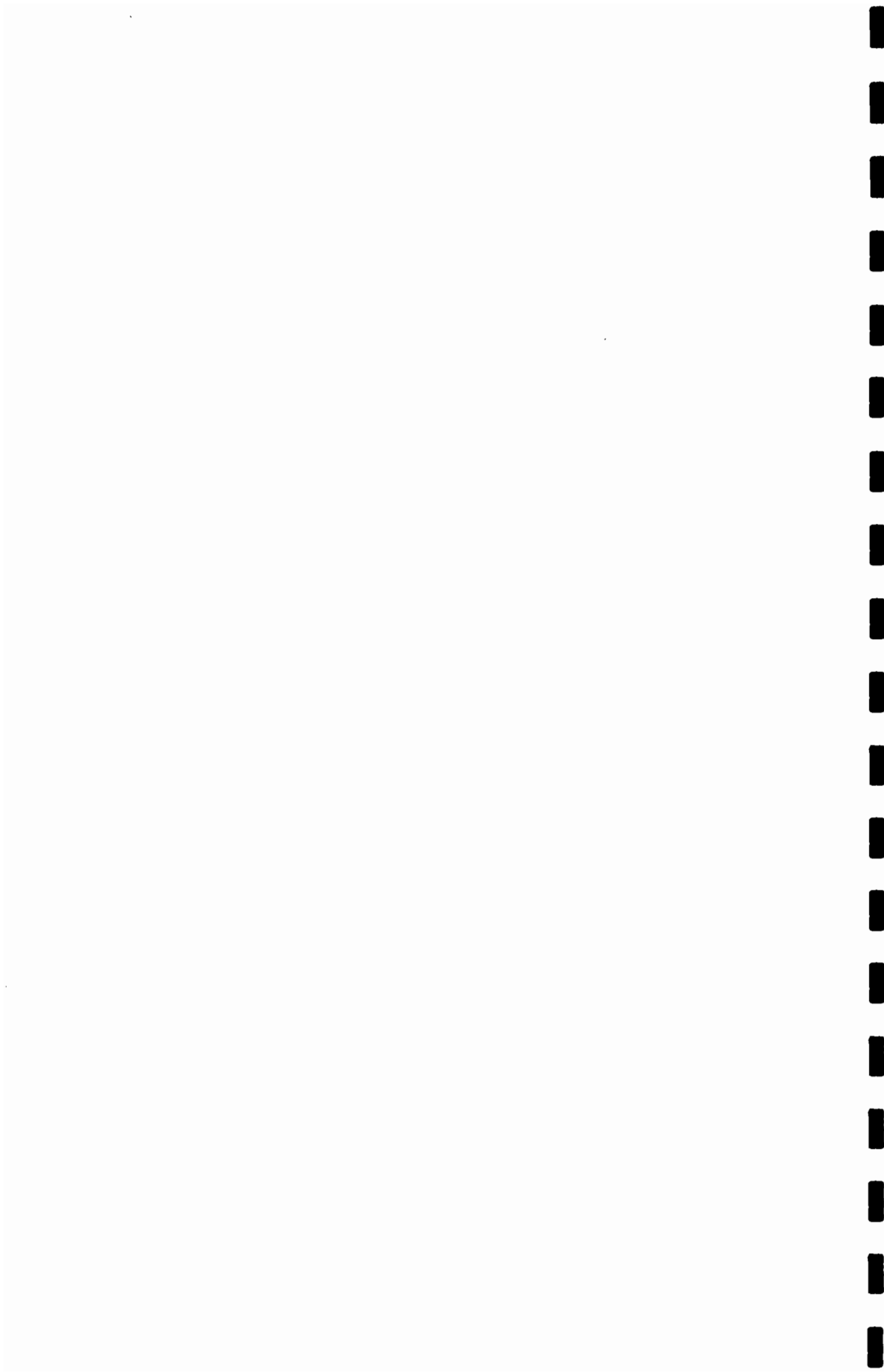


Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710		Test Boring/Well Construction Log			
Project : R F I					Boring No. MW-16B
Client : NGK Metals Corporation					Sheet 1 of 3
Purpose : Monitoring Well Installation					Job No. 3943-5-5756
Drilling Contractor : Eichelberger			Driller : Weigle/Knaub		Total Depth 200 ft.
Geologist : J. J. Painter			Specifications Type Diameter	Hammer Weight lbs.	Date Started 9/19/89
Time Log:	Begin	Finish	Depth	Casing steel 125'x 6"	Notes: Date Finished 11/2/89 S.W.L. 179.55 ft. <u>TOC/GL</u> Elevation TOC Surface 327.54 ft. 326.17 ft.
				Bore rock 6"	
				Well open 6"	
				Sampler	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-4'				orange brown clay	
4-9'				weathered olive grey to light grey limestone	
9-25'				light to medium grey limestone, with calcite fragments	
25-26'				olive grey dolomite,	
26-40'				light to medium grey limestone	
40-47'				olive grey dolomite	
47-54'				light to medium grey limestone	
54-55'				olive grey dolomite,	
55-60'				light to dark grey limestone, iron stained	red shaly zones

DUNN GEOSCIENCE CORPORATION

AR360394



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-16B

Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-75' light to dark grey limestone, trace red shaly zones, iron staining	
70				75-123' medium to dark grey limestone, trace calcite	
80					
90					
100					96-106' broken zone
110					
120				123-124' fractured zone, weathered shale	
130				124-200' medium to dark grey limestone, with calcite fragments	thin sandstone layer estimated water ~ 1 gpm
140					

DUNN GEOSCIENCE CORPORATION

AR360395



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-16B

Client : NGK Metals Corporation

Sheet 3 of 3

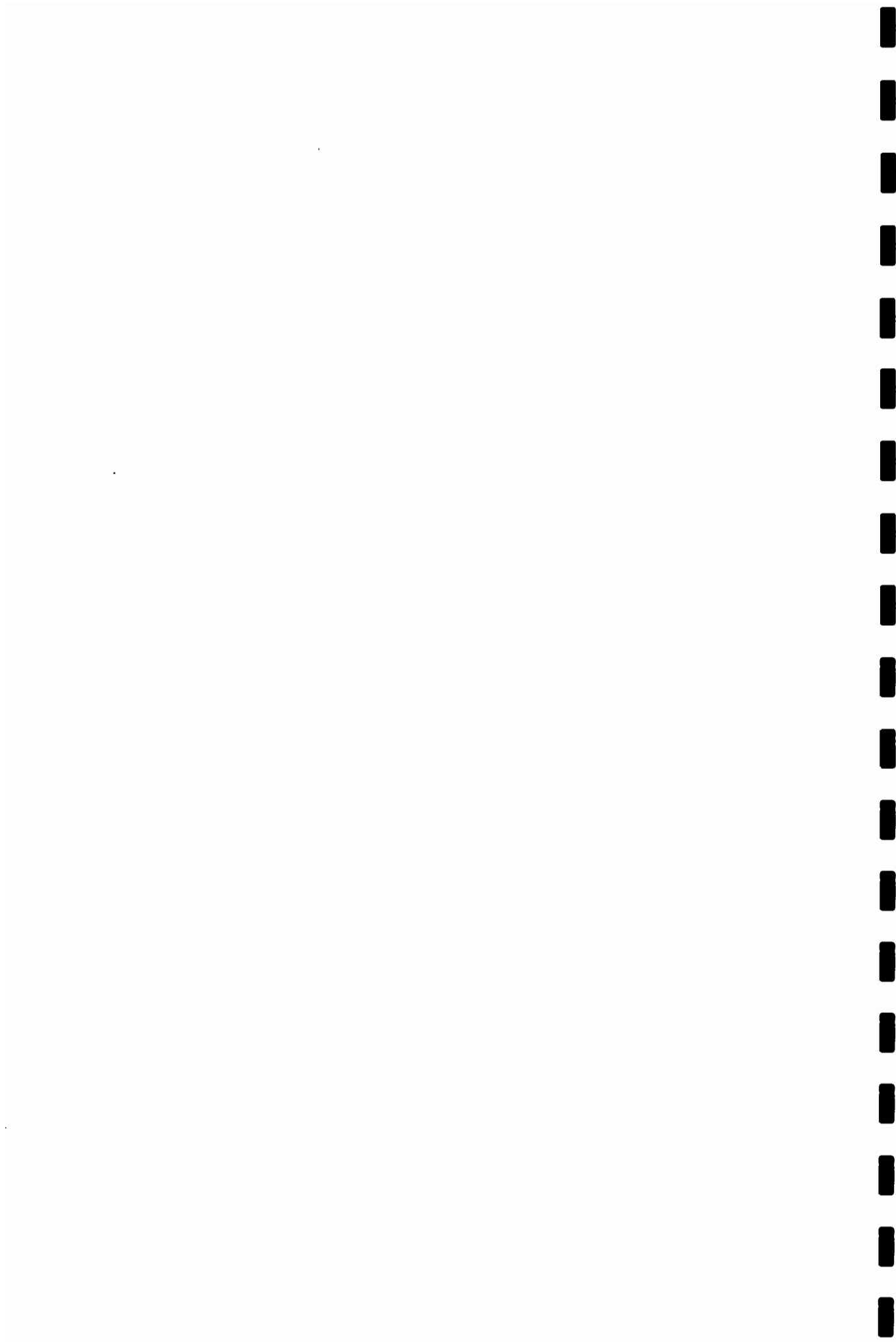
Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
140				140-200' medium to dark grey limestone	
150					
160					
170					
180					
190					
200					final estimated flow is <2 gpm

DUNN GEOSCIENCE CORPORATION

AR360396

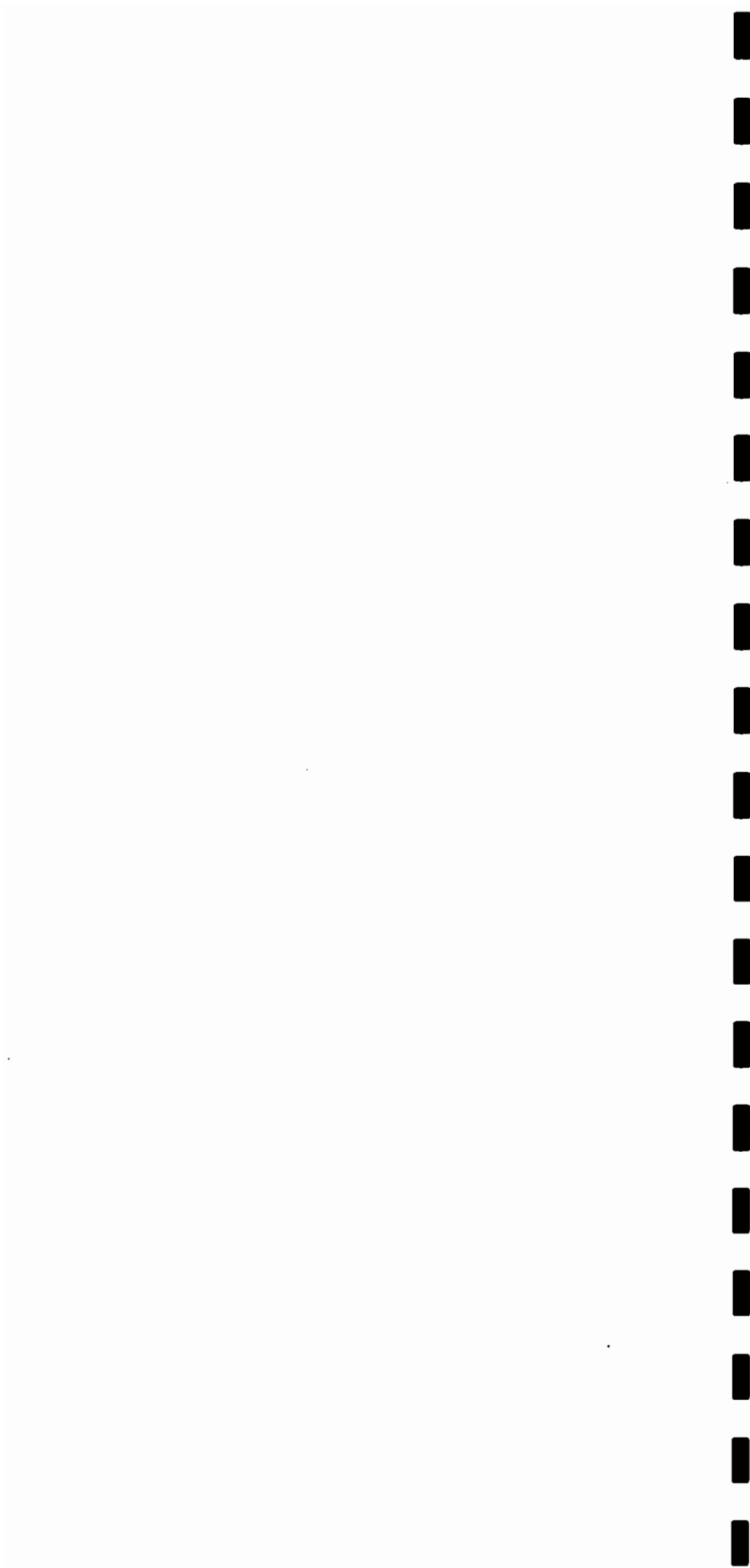






Dunn Geoscience Corporation Mechanicsburg, PA (717) 671-6710				Test Boring/Well Construction Log			
Project : R F I						Boring No. MW-17B	
Client : NGK Metals Corporation						Sheet 1 of 3	
Purpose : Monitoring Well Installation						Job No. 37-3943-5756	
Drilling Contractor : Eichelberger				Driller : K. Weigle		Total Depth 200 ft.	
Geologist : J. J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 9/6/89	
Time Log: Begin Finish Depth				Casing	steel	125'x 6"	Notes:
				Bore	rock	6"	
				Well	open	6"	
				Sampler			
						Date Finished 9/18/89	
						S.W.L. 48.90 ft. TOC/GL	
						Elevation TOC Surface	
						319.39 ft. 317.62 ft.	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-22'				reddish brown clay, traces of weathered dolomite	damp
10					moist
20				22-23' dark grey shale	used water to return cuttings
				23-29' medium to dark grey dolomite	25-27': trace olive grey shale & sandstone
30				29-31' broken zone with clay	31': rod dropped, lost circulation
				31-34' open	
40				34-46' dolomite, occasional brown shaly cuttings and calcite, limestone interbeds	
50				46-58' medium to dark grey limestone, calcite veins	
60				58-60' weathered shale	dark grey and brown, trace quartzite, limonite stain



Dunn Geoscience Corporation

Mechanicsburg, PA (717) 671-6710

Test Boring/Well Construction

Project : R F I

Boring No. MW-17B

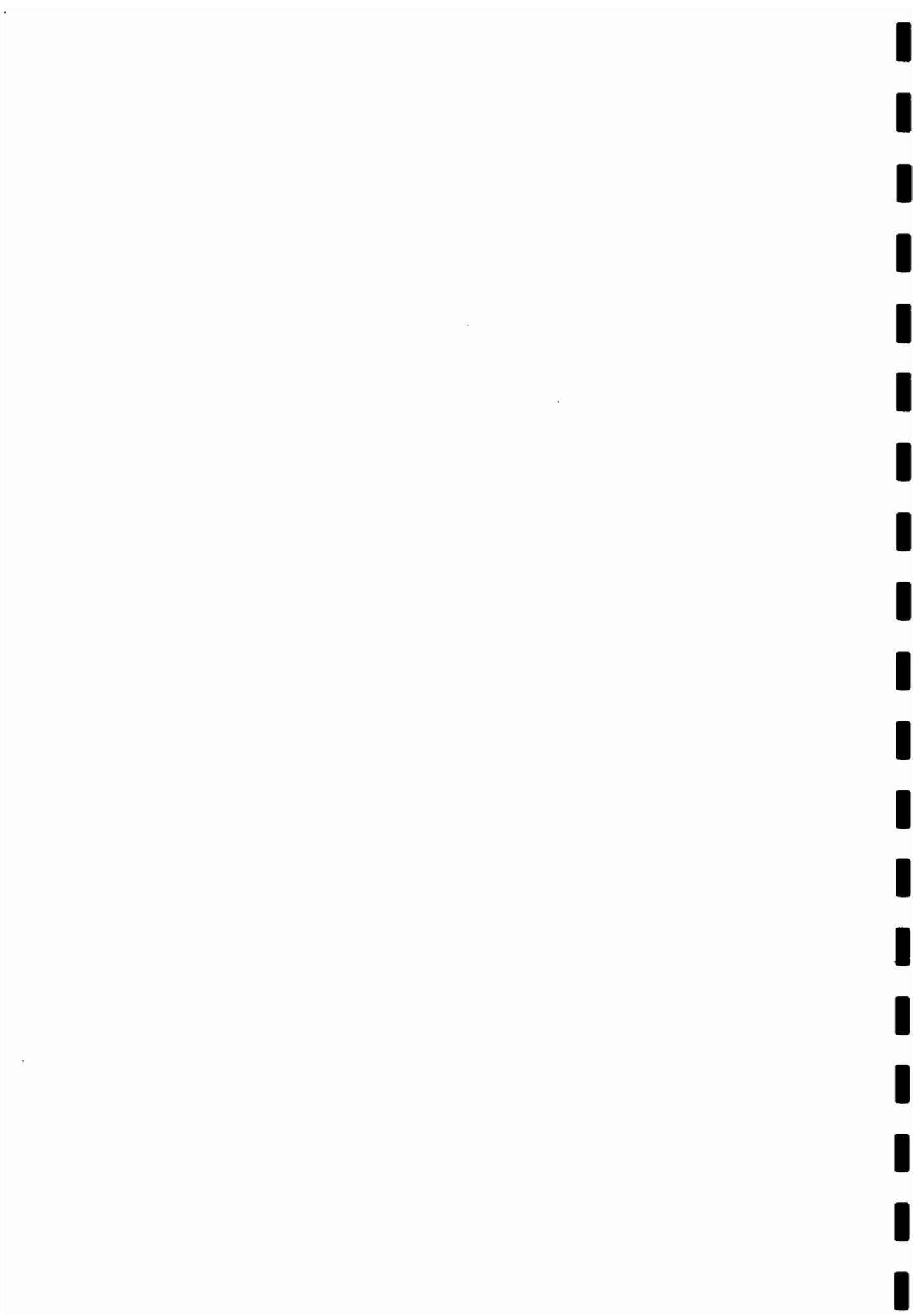
Client : NGK Metals corporation

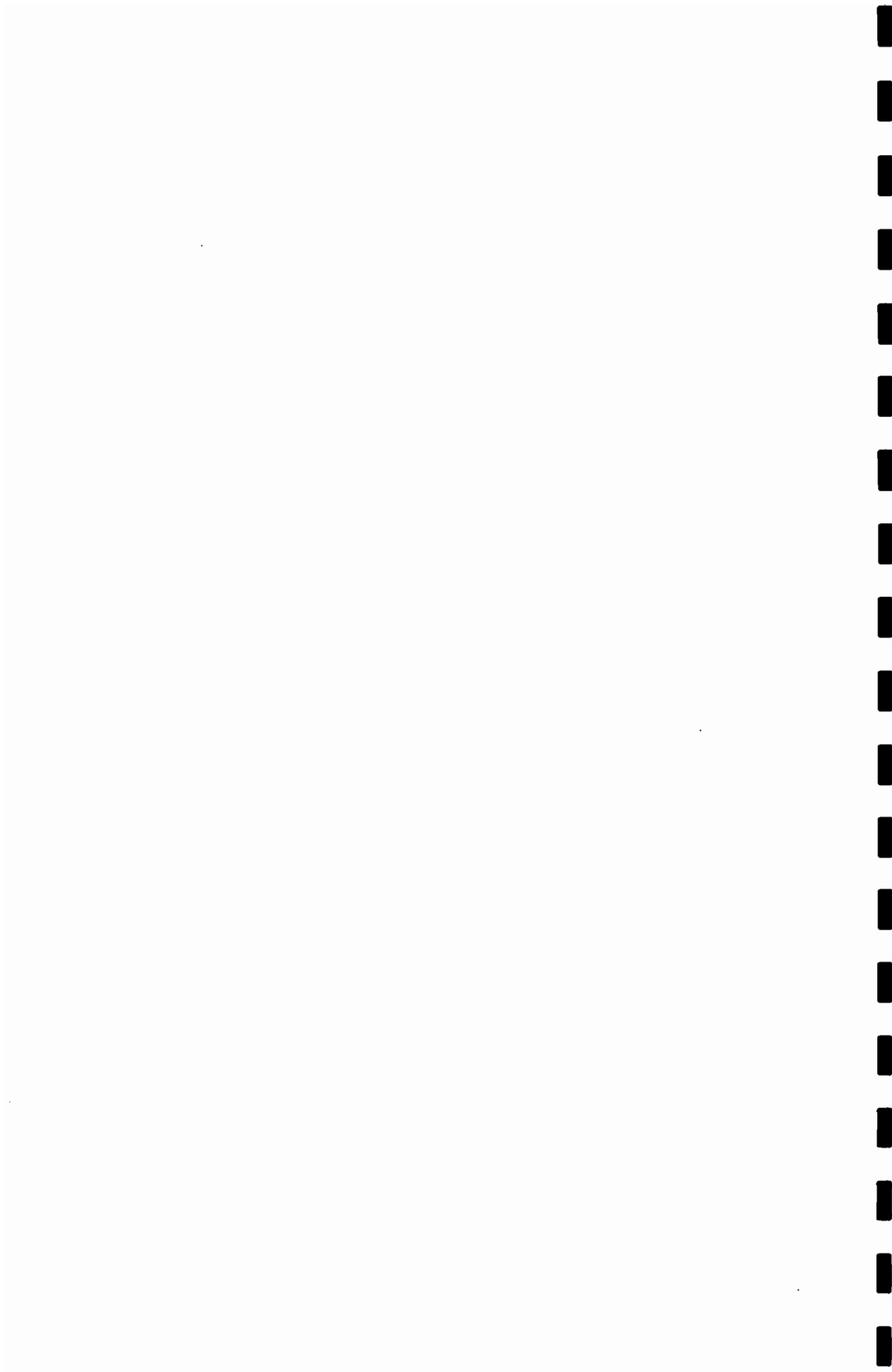
Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60-102' medium to dark grey limestone, calcite veins	68-93':used very little foam to help lift cuttings,return was sporadic, consumed by void @ 31-34 ft.
70					
80					
90					
100				102-112' medium to dark grey dolomite and limestone, interbedded, trace brown shale, calcite veins	softer,cuttings were larger,little water return
110				112-140' limestone with calcite fragments	
120					
130					
140					

DUNN GEOSCIENCE CORPORATION

AR360400



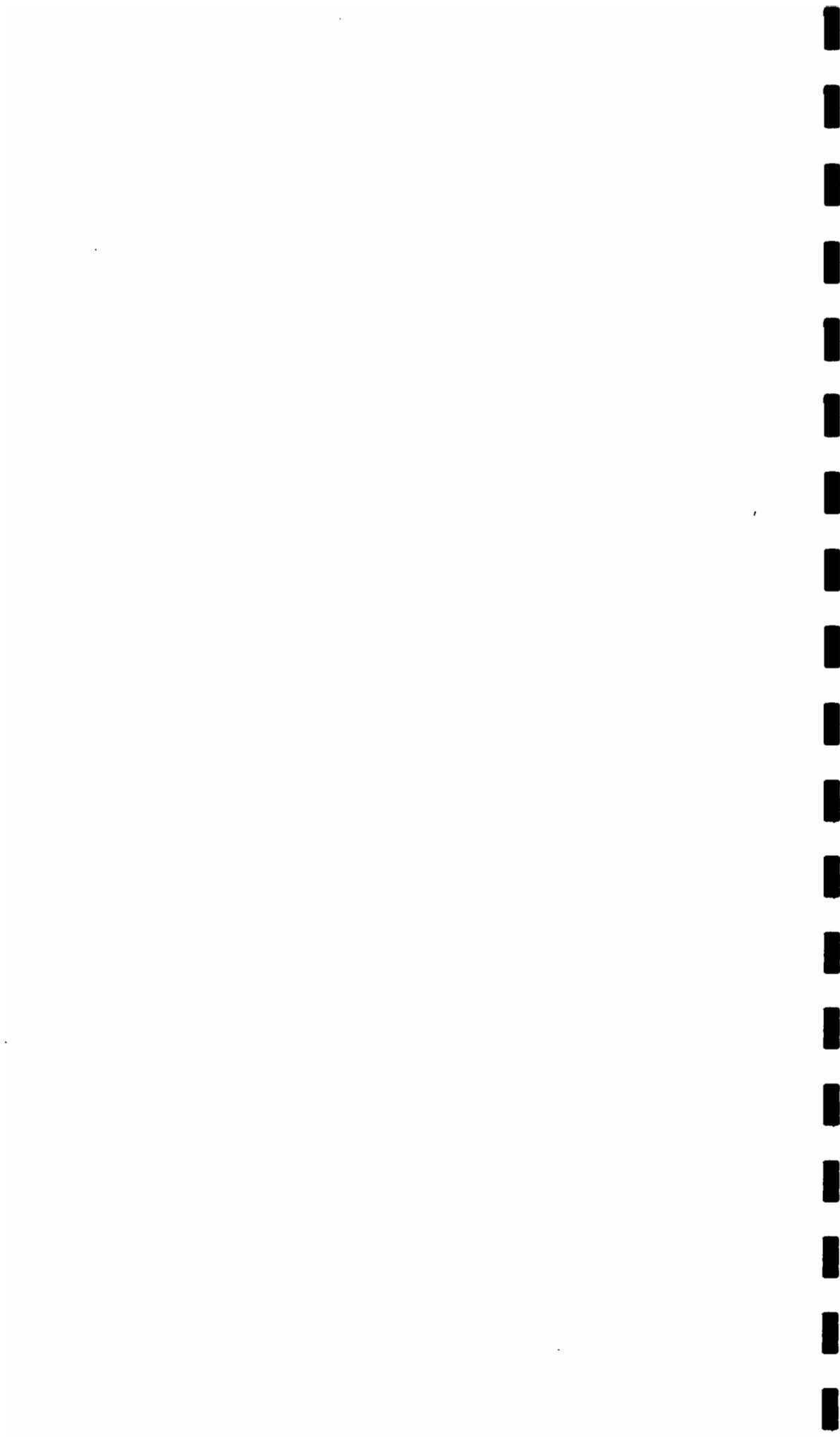


Test Boring/Well Construction Log

Project : NGK Metals RFI								Boring No. DW-27			
Client : NGK Metals Corporation								Sheet 1 of 2			
Purpose : Corrective Measures								Job No. 35525.300			
Drilling Contractor : Eichelberger						Driller : C. Knaub		Total Depth 118 Ft.			
Geologist : J. Painter				Specifications		Type		Diameter	Hammer Weight: lbs.	Date Started 6/17/93	
Time Log:		Begin	Finish	Depth	Casing	Manhole	8"	Notes: 4"x 020 slot pvc screen 118'-68' morie #1 qtz sand and pea gravel 118'-62.5', bentonite 62.5'-47', bemseal grout 47'-1.5'.		Date Finished 6/23/93	
				Bore	Tubex	8"	S.W.L. 52 Ft.			TOC/GL	
				Well	PVC	4"	Elevation TOC			Surface	
				Sampler			328.20			328.20	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1.5'				macadam, gravel fill	Three stainless steel centralizers from 68'-118' Bentonite/cement grout 1.5'-surface
1.5'-54'				brown clay with brown shale, grey limestone, and reddish-white quartzite fragments	
10					
20					
30					
40					
50					
				54'-68' broken grey limestone	

AR360402



Test Boring/Well Construction

Project : NGK Metals RFI

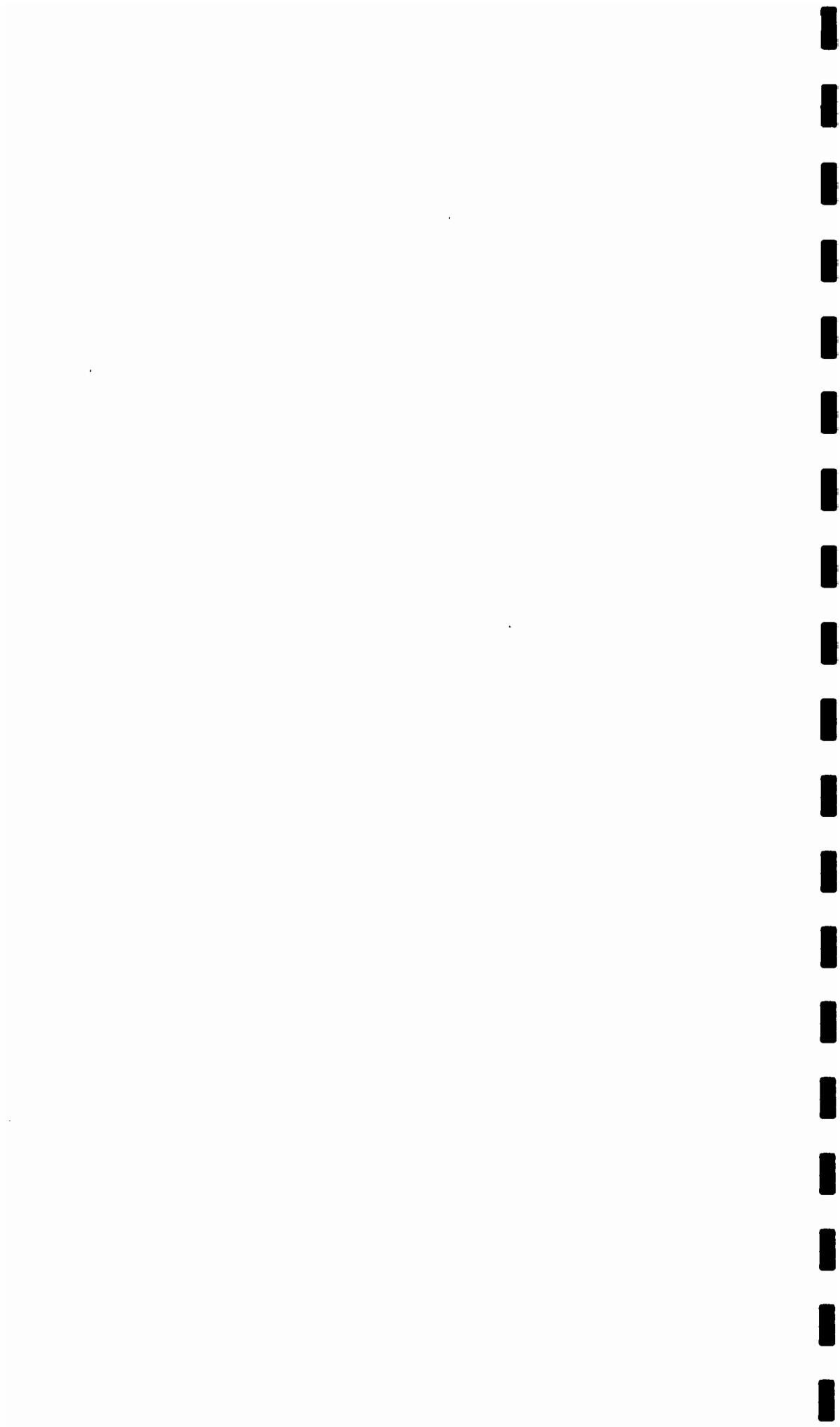
Boring No. DW-27

Client : NGK Metals Corp.

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
68					
69					
70				68'-72' void or clay seam	water bearing zone (no estimate)
71					
72				72'-83' grey limestone	
73					
74					
75					
76				77'-78' broken zone	water bearing zone
77					
78					
79					
80				83'-85' void or clay seam	
81					
82					
83				85'-118' grey limestone	
84				85'-91' broken zone	water bearing zone
85					
86					
87					
88					
89					
90					
91					
92					
93				93'-111' broken zone	water bearing zone
94					
95					
96					
97					
98					
99					
100					
101					
102					
103					
104					
105					
106					
107					
108					
109					
110					
111					
112					
113					
114					
115					
116					
117					
118				118' Bottom of hole	Final flow 10-20 gpm
119					
120					
121					
122					
123					
124					
125					
126					
127					
128					
129					
130					

AR 360403

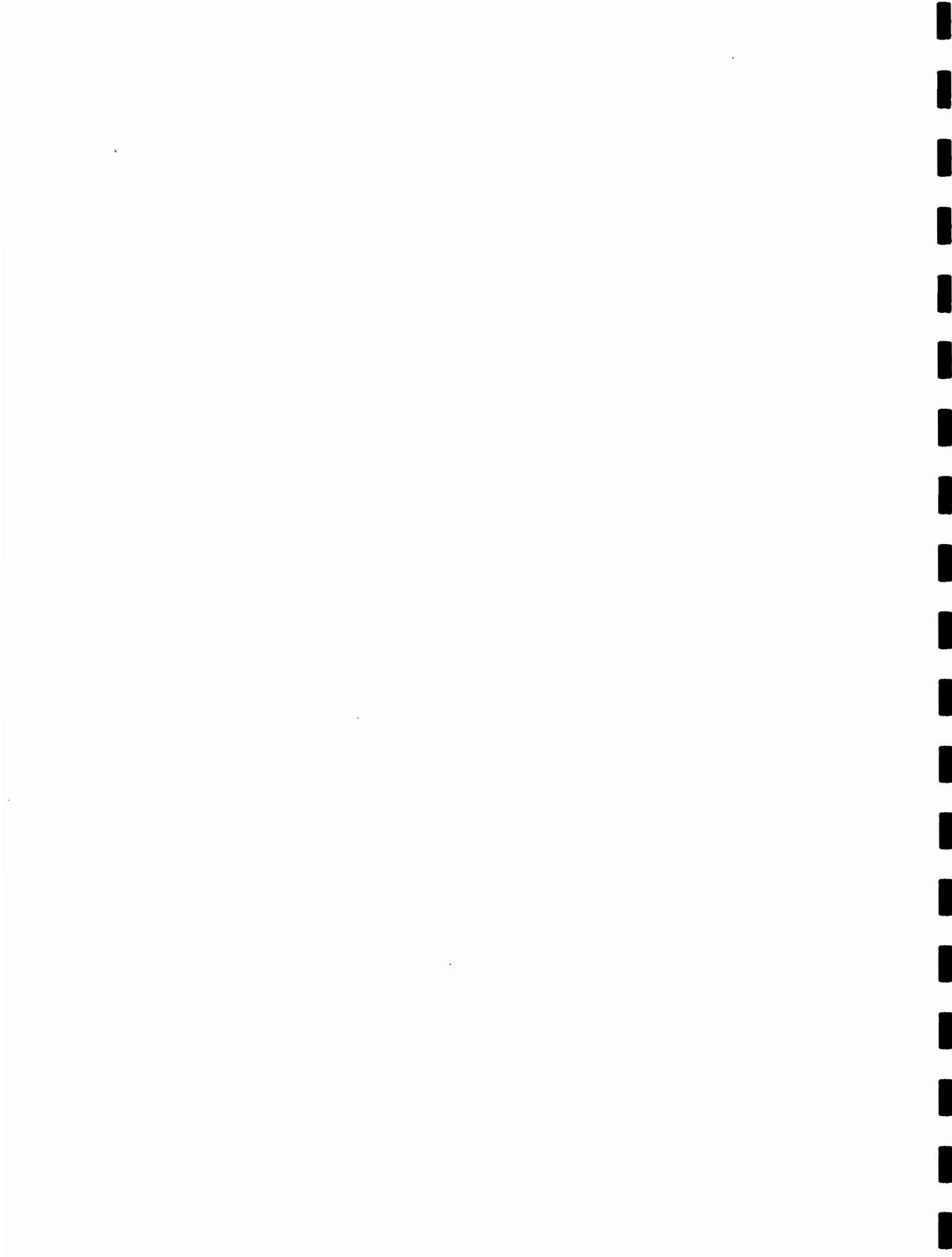


Test Boring/Well Construction Log

Project : NGK Metals RFI				Boring No. DW-28			
Client : NGK Metals Corporation				Sheet 1 of 2			
Purpose : Corrective Measures				Job No. 35525.300			
Drilling Contractor : Eichelberger				Driller : C. Knaub			
Geologist : J. Painter				Date Started 6/23/93			
Specifications				Date Finished 6/29/93			
Time Log: Begin Finish Depth				Notes: 4"x 020 slot pvc screen 120'-70'			
				S.W.L. 50 Ft. TOC/GL			
				Elevation TOC Surface			
				327.10 327.10			

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-4'				macadam, gravel fill	Three stainless steel centralizers from 70'-120' Cement/benseal grout 1.5-surface
4'-57'				orangish-brown sandy and silty clay	
10					
20					
30					
40					
50					
				57'-63' grey shale, quartzite gravel and brownish-red sandstone fragments	

AR360404




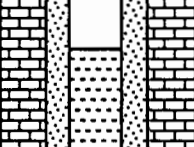


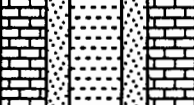


Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. DW-28

Client : NGK Metals Corp.

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
63'-74'				grey limestone, broken, occasional clay seam or void	water bearing zone
74'-120'				grey limestone	water bearing zone 76'
82'-84'				broken zone	water bearing zone 82' ~ 5 gpm total flow
87'-88'				broken zone	water bearing zone
99'-100'				broken zone	water bearing zone - ~7 gpm
103'-106'				broken zone	
120'				Bottom of hole	Final flow ~7-10 gpm

AR360405

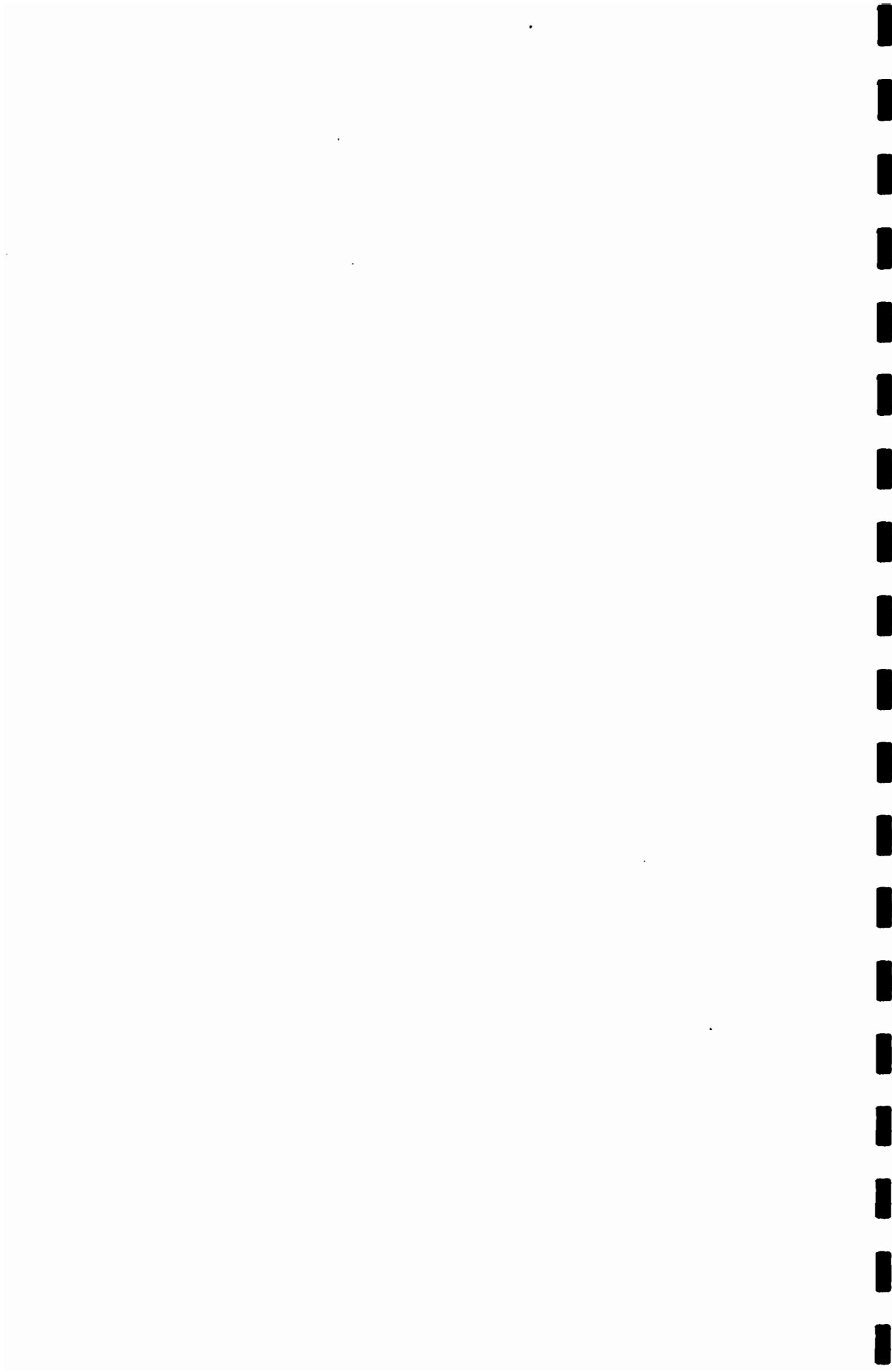


Test Boring/Well Construction Log

Project : NGK Metals RFI							Boring No. DW-29		
Client : NGK Metals Corporation							Sheet 1 of 2		
Purpose : Corrective Measures							Job No. 35525.300		
Drilling Contractor : Eichelberger				Driller : C. Knaub			Total Depth 120 Ft.		
Geologist : J. Painter/T. Seibert				Specifications		Hammer Weight:		Date Started 6/29/93	
				Type	Diameter	lbs.			
Time Log: Begin Finish Depth				Casing	Manhole	12"	Notes: 6"x 020 slot pvc screen 120'-60' morie #1 qtz sand 121'-54', bentonite 54'-51', benseal grout 51'-1.5'	Date Finished 7/6/93	
				Bore	Tubex	8"		S.W.L. 50 Ft. <u>TOC/GL</u>	
				Well	PVC	6"		Elevation TOC Surface	
				Sampler				325.61 325.61	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-2'				macadam, gravel fill	Three stainless steel centralizers from 60'-120' Bentonite/cement grout 1.5'-surface
2'-10'				red mud, moist	
10-40'				orangish-brown clay, trace shale fragments	
40'-50'				orangish-brown clay with quartz and sandstone fragments, occasion- al shale fragment	
50'-53'				orangish-brown clay with sandstone, light grey and buff thinly bedded, severely weathered dolomite frag- ments	
53'-70'				light grey and buff, thinly bedded dolomite, severely weathered	

AR360406



Test Boring/Well Construction

Project : NGK Metals RFI

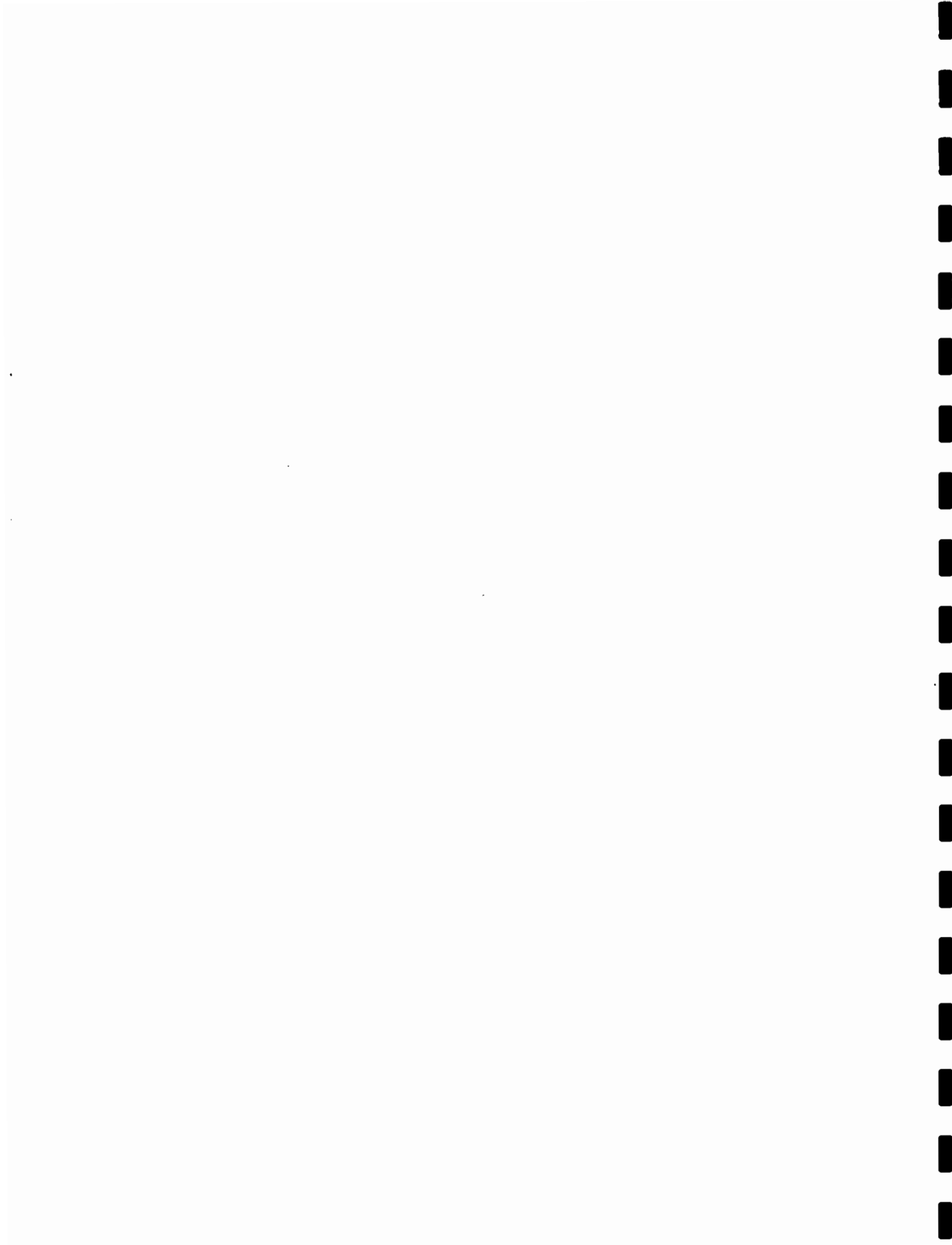
Boring No. DW-29

Client : NGK Metals Corp.

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
70				70'-73' light to medium grey limestone with occasional sandstone fragments	
				73'-76' grey limestone	
				73'-74' broken zone	
				75'-76' weathered/broken zone	
80				slightly muddy water	Total flow <5 gpm
				76'-82' light to medium grey limestone interbedded with light brown dolomite	
				82'-89' severely weathered limestone, broken zone, muddy water	Major water bearing zone 82'
90				89'-112' grades to medium to dark grey limestone	
100					
110				110'-112' broken zone	water bearing zone 110'-112'
				112'-120' medium grey to olive grey limestone	
120				120' Bottom of hole	Final flow >60 gpm
130					

AR360407





**ENVIRONMENT &
INFRASTRUCTURE**

2 Market Plaza Way
Mechanicsburg, PA 17055 (717) 795-8001
(717) 795-8280 (FAX)

Test Boring/Well Construction Log

Project : NGK Metals RFI				Boring No. DW-30			
Client : NGK Metals Corporation				Sheet 1 of 2			
Purpose : Corrective Measures				Job No. 35525.300			
Drilling Contractor : Eichelberger				Driller : C. Knaub		Total Depth 121 Ft.	
Geologist : T. Seibert		Specifications		Type	Diameter	Hammer Weight: lbs.	Date Started 7/7/93
Time Log:	Begin	Finish	Depth	Casing	Steel	8"	Notes: 4" 020 slot pvc screen 120'-60' morie #1 qtz sand 121'-54', bentonite 54'-45', benseal 45'-1.5'
				Bore	Tubex	8'	
				Well	PVC	4"	
				Sampler			
				S.W.L. 50 Ft.		TOC/GL	Elevation TOC Surface
				326.51		325.57	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-2'				soil	Three stainless steel centralizers from 60'-120' Bentonite/cement grout 1.5' to surface
2'-7'				slag, glass and soil	
7'-34'				orangish-brown silty and sandy soil	
34'-48'				Buff to grey limestone and dolomite with greenish phyllite beds, broken	low water yield
48'-52'				Same as 34'-48', competent	
52'-64'				Dark grey to blueish limestone with occasional tan to greenish beds, grades to light grey	

AR360408

Test Boring/Well Construction

Project : NGK Metals RFI

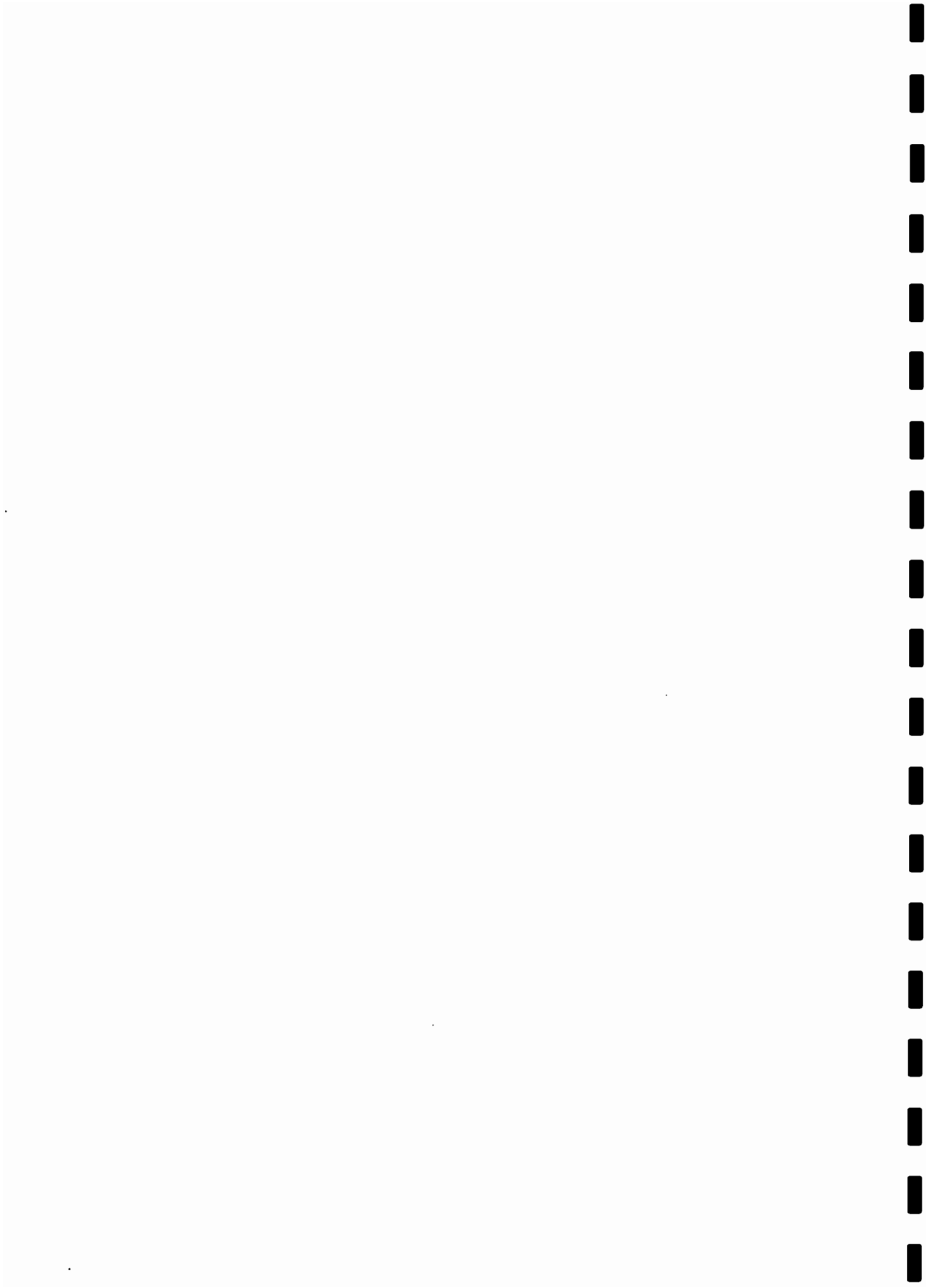
Boring No. DW-30

Client : NGK Metals Corp.

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
64'-82'				light grey, brownish-grey to grey limestone and dolomite	
64'-71"				weathered zone	
82'-86'				light tan dolomite	
86'-121'				grades to light grey, brownish-grey to grey limestone and dolomite	
93'				weathered	water bearing zone 93'
105'					water bearing zone 105'
112'					water bearing zone 112'
121'				Bottom of hole	Final flow ~10 gpm
130'					

AR360409



Test Boring/Well Construction Log

Project : NGK Metals RFI				Boring No. DW-31			
Client : NGK Metals Corporation				Sheet 1 of 3			
Purpose : Corrective Measures				Job No. 35525.300			
Drilling Contractor : Eichelberger				Driller : C. Knaub		Total Depth 153 Ft.	
Geologist : J. Painter				Specifications Type Diameter		Hammer Weight lbs.	
Time Log: Begin Finish Depth				Casing	Steel	18"x6"	Notes: Shale trap at end of 6' steel casing (16'), cement/bentonite grout 16'-0
				Bore	rotary	8'	
				Well	open	8"	
				Sampler			
						Date Started 7/13/93	
						Date Finished 7/15/93	
						S.W.L. 50 Ft. TOC/GL	
						Elevation TOC Surface	
						331.30 328.89	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-3'				overburden fill, gravel	
3'-153'				grey limestone	
10					
20					
30				23'-25' fracture zone	
40					
50				45'-46' broken zone	
				54'-55' broken zone	

AR360410

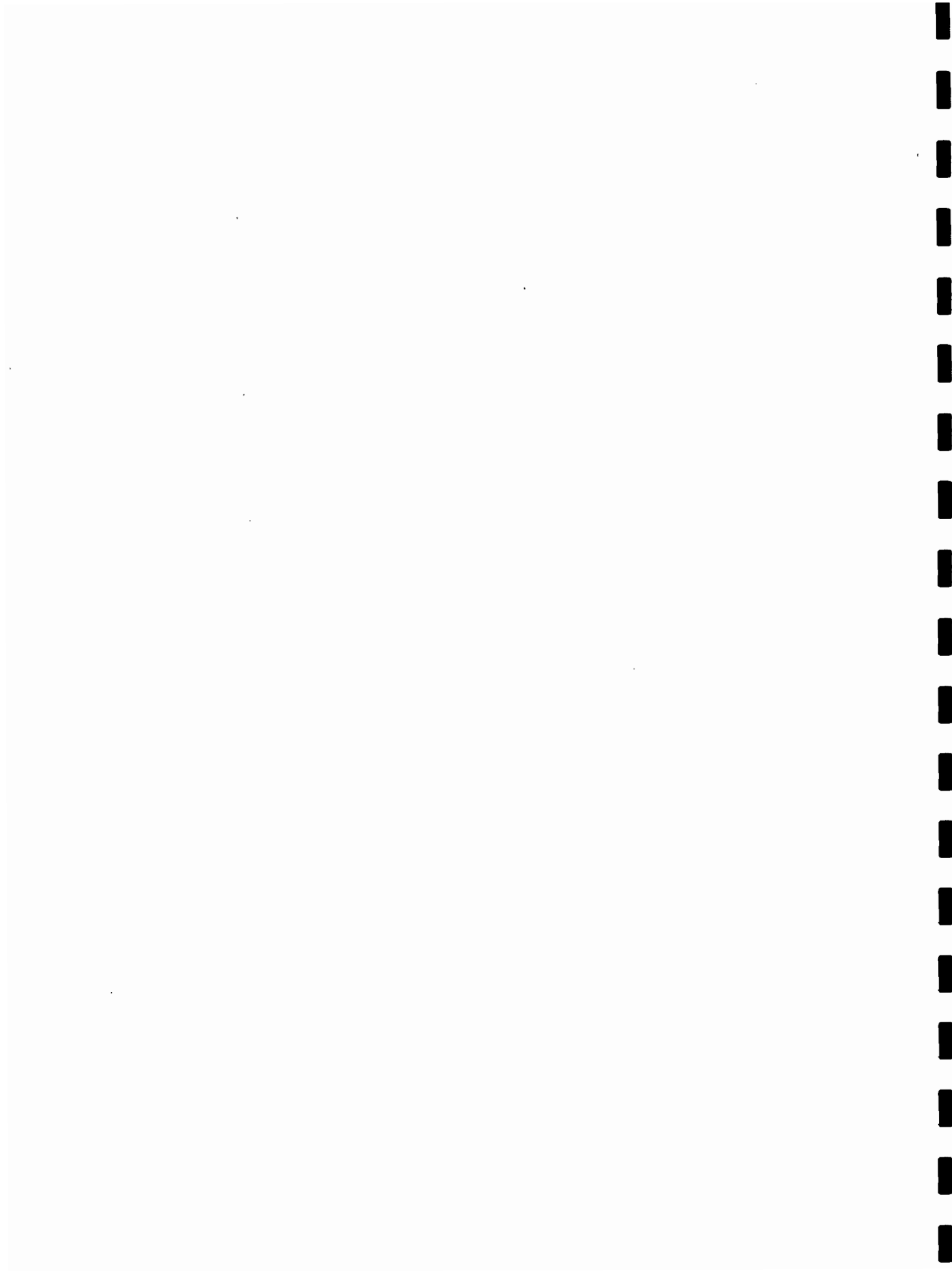




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Sheet 2 of 3

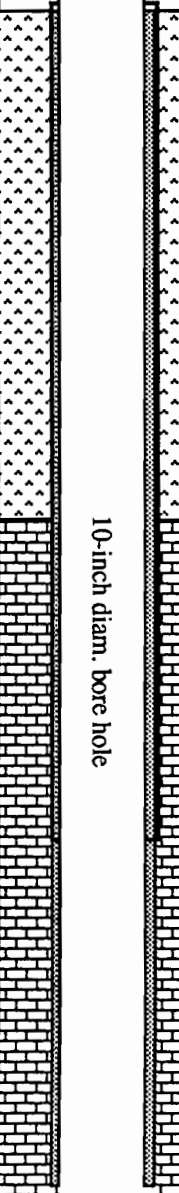
AR360411



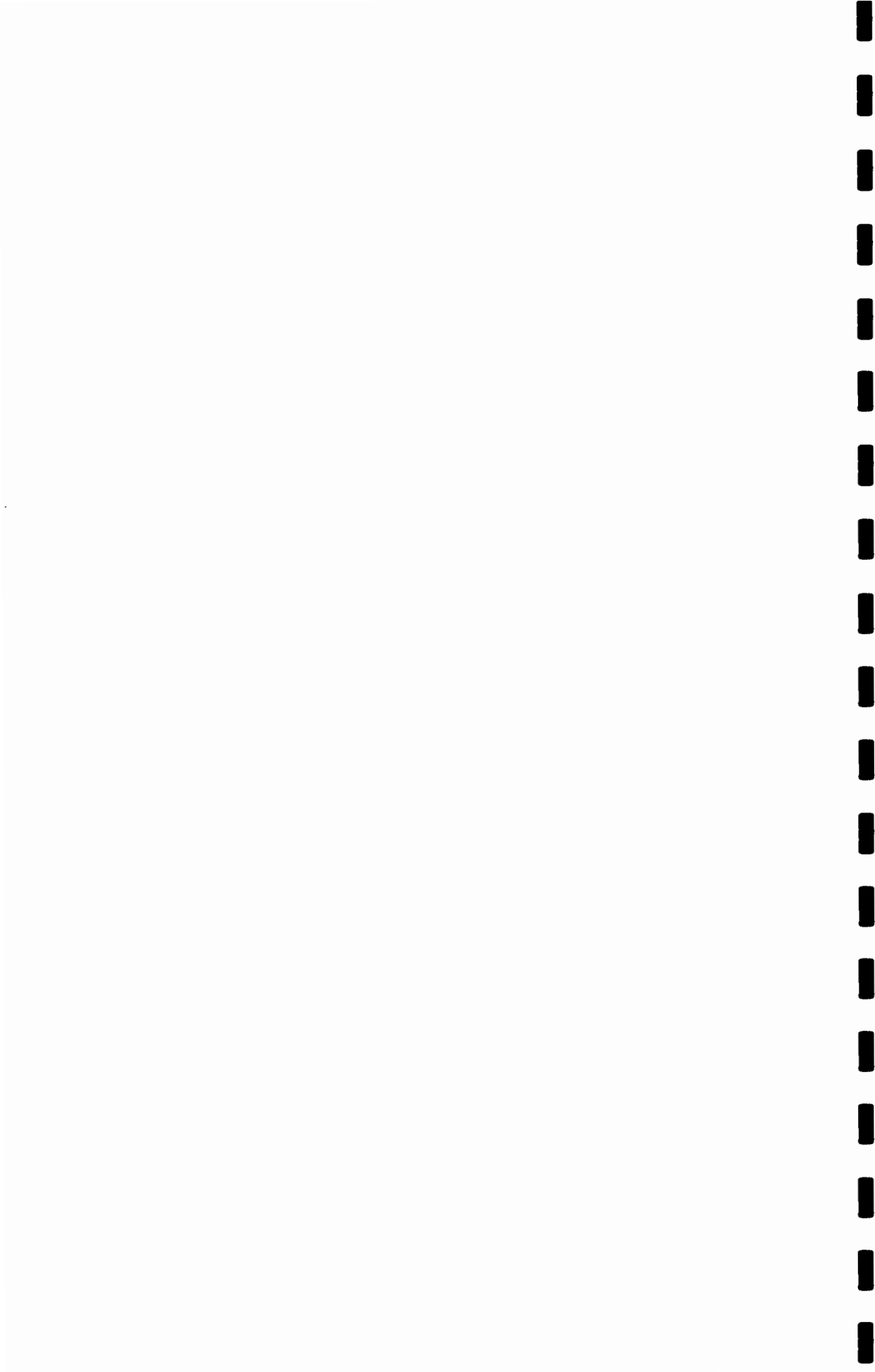


Test Boring/Well Construction Log

Project : NGK Metals RFI							Boring No. DW-32		
Client : NGK Metals Corporation							Sheet 1 of 3		
Purpose : Corrective Measures							Job No. 35525.300		
Drilling Contractor : Eichelberger				Driller : J. Books			Total Depth 150 Ft.		
Geologist : J. Painter & G. Buterbaugh				Specifications		Hammer Weight: lbs.	Date Started 2/21/94		
Time Log: Begin Finish Depth				Casing	Steel		8" & 10"	Date Finished 2/7/94	
				Bore	rotary		8'	S.W.L. 36.62 Ft. <u>TOC/GL</u>	
				Well	open		8"	Elevation TOC Surface	
				Sampler				319.49 316.79	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
10				0-1', overburden fill, limestone gravel	Ten-inch bore hole to 62 feet, then 7 7/8-inch bore hole to 150 feet. 10-inch diameter steel casing set to 42 feet, 8-inch diameter steel casing with drive shoe set to 59 feet.
				1'-36', LOAM, orange-brown with quartzite gravel	
20					
30					
40				36'-44', bedrock, broken, weathered with soft muddy zone from 37' to 44'.	
50				44'- 48', DOLOSTONE, medium to dark gray, broken, weathered, intermittent muddy/clay zones, occasional red stained fragment.	
				48' - 117', DOLOSTONE, medium gray, competent, occasional iron staining at 110 feet.	~Q: 1 - 2 gpm ~ Q: 1 gpm at 63 feet.

AR360413



Test Boring/Well Construction

Project : NGK Metals RFI

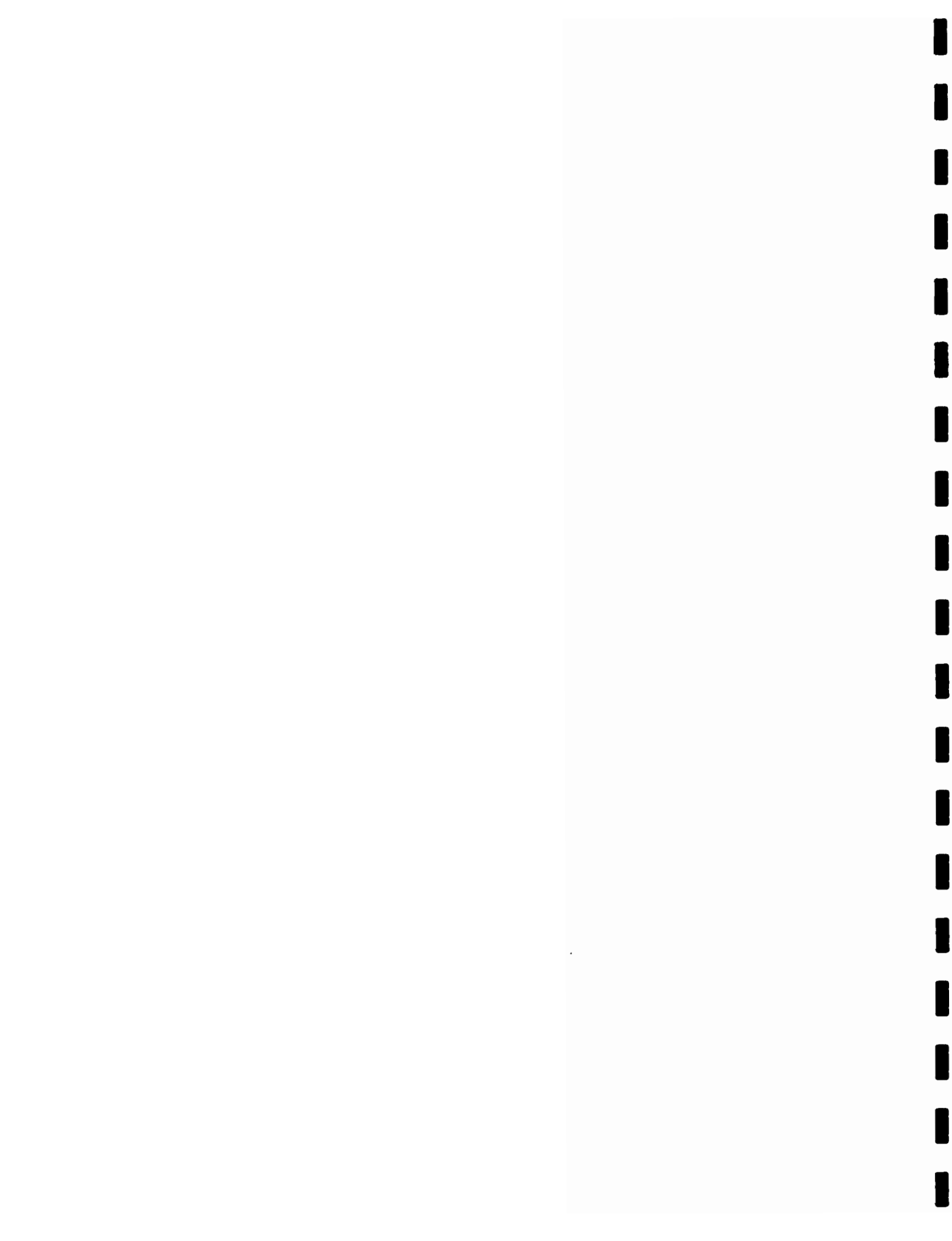
Boring No. DW-32

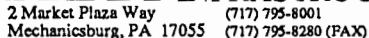
Client : NGK Metals Corp.

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
70			10-inch	48' - 117', DOLOSTONE, medium gray, competent, occasional iron staining at 110 feet.	
80			8-inch diam. bore hole		
90					
100					
110					
120				121' - 123', DOLOSTONE, medium to dark gray, noticeable quartz content increase. 123' - 138, DOLOSTONE, medium gray, micro - very finely crystalline, occasional calcite filled fracture with limonite staining.	
130				138' - 143', as above with occasional friable brown silt to very fine grained quartz sand.	noticeable increase in Q.

AR360414

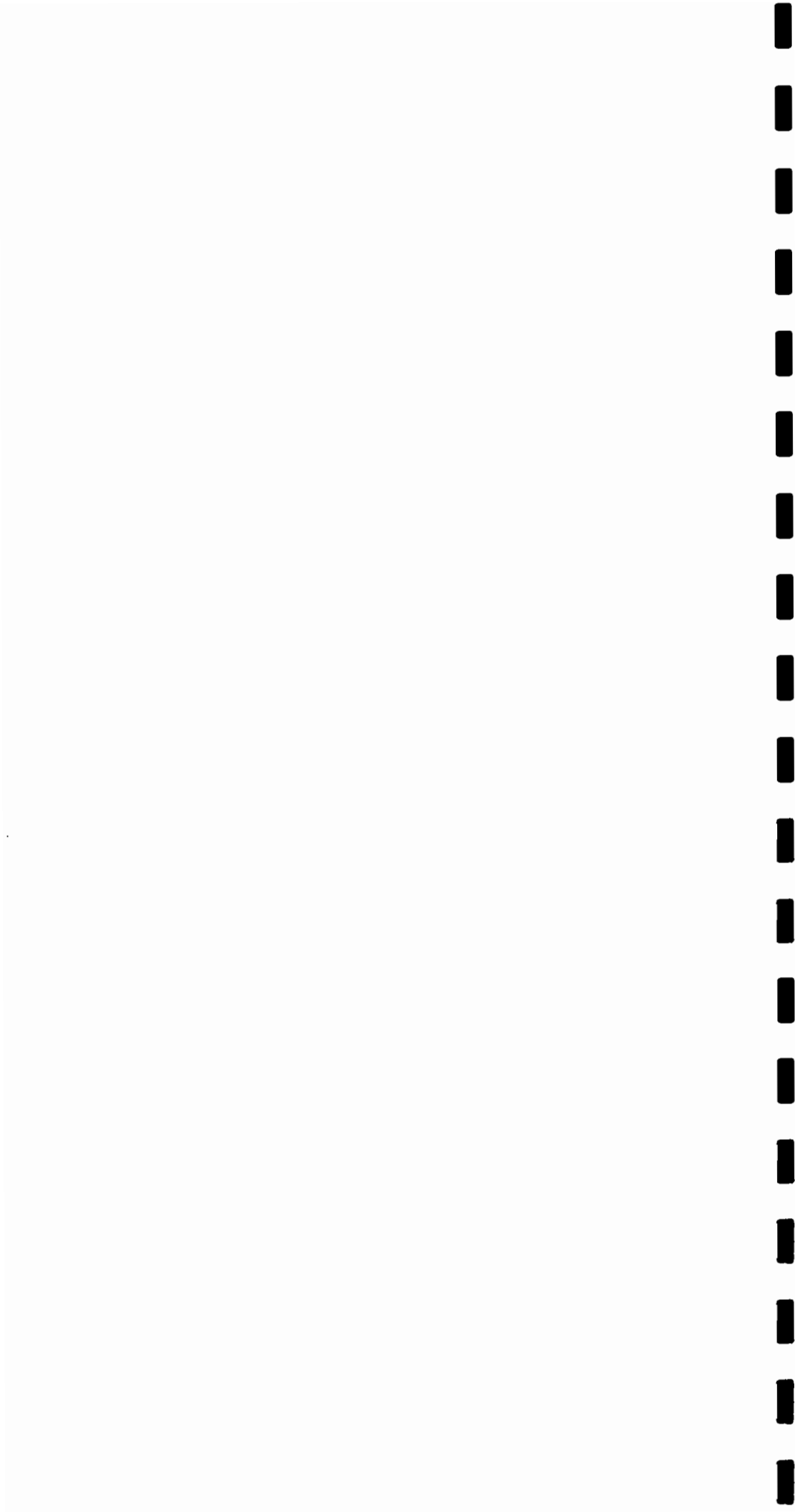




Sheet 3 of 3

Final flow (Q) 10 to 12 gpm

AR360415

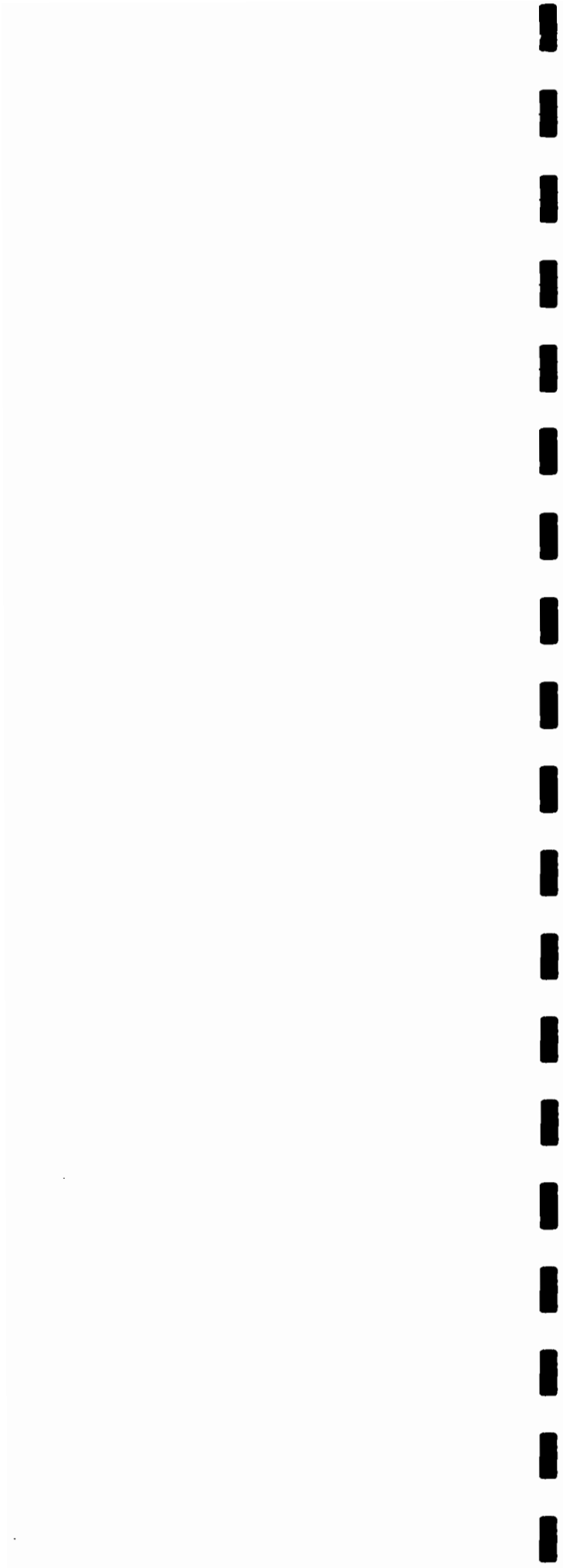


Test Boring/Well Construction Log

Project : NGK Metals RFI				Boring No. DW-33			
Client : NGK Metals Corporation				Sheet 1 of 2			
Purpose : Corrective Measures				Job No. 35525.300			
Drilling Contractor : Eichelberger				Driller : K. Weigle			
Geologist : T. Seibert & G. Buterbaugh				Total Depth 130 Ft.			
Specifications				Date Started 3/9/94			
Type Diameter Hammer Weight lbs.				Date Finished 3/15/94			
Time Log:	Begin	Finish	Depth	Casing	Steel	5'x8"	Notes:
				Bore	rotary	8'	
				Well	PVC	4"	
				Sampler			
				S.W.L. 37.3 Ft. TOC/GL			
				Elevation TOC Surface			
				321.33 319.63			

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-3'				overburden fill, orange-brown soil and gravel	Ten-inch bore hole to 119 feet, then 7 7/8-inch bore hole to 130 feet.
3'-82'				soil-clayey, orange-brown to brown	Well Materials:
10					4" PVC 020-slot screen 58'-128'
					4" PVC riser +1.5'-58'
					Morie #1 quartz sand 58'-130'
20					00 quartz sand 56'-58'
					Bentonite pellets 54'-56'
					Bentonite/grout mix 54'-surface
30					
40					
50					

AR360416



Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. DW-33

Client : NGK Metals Corp.

Sheet 2 of 2

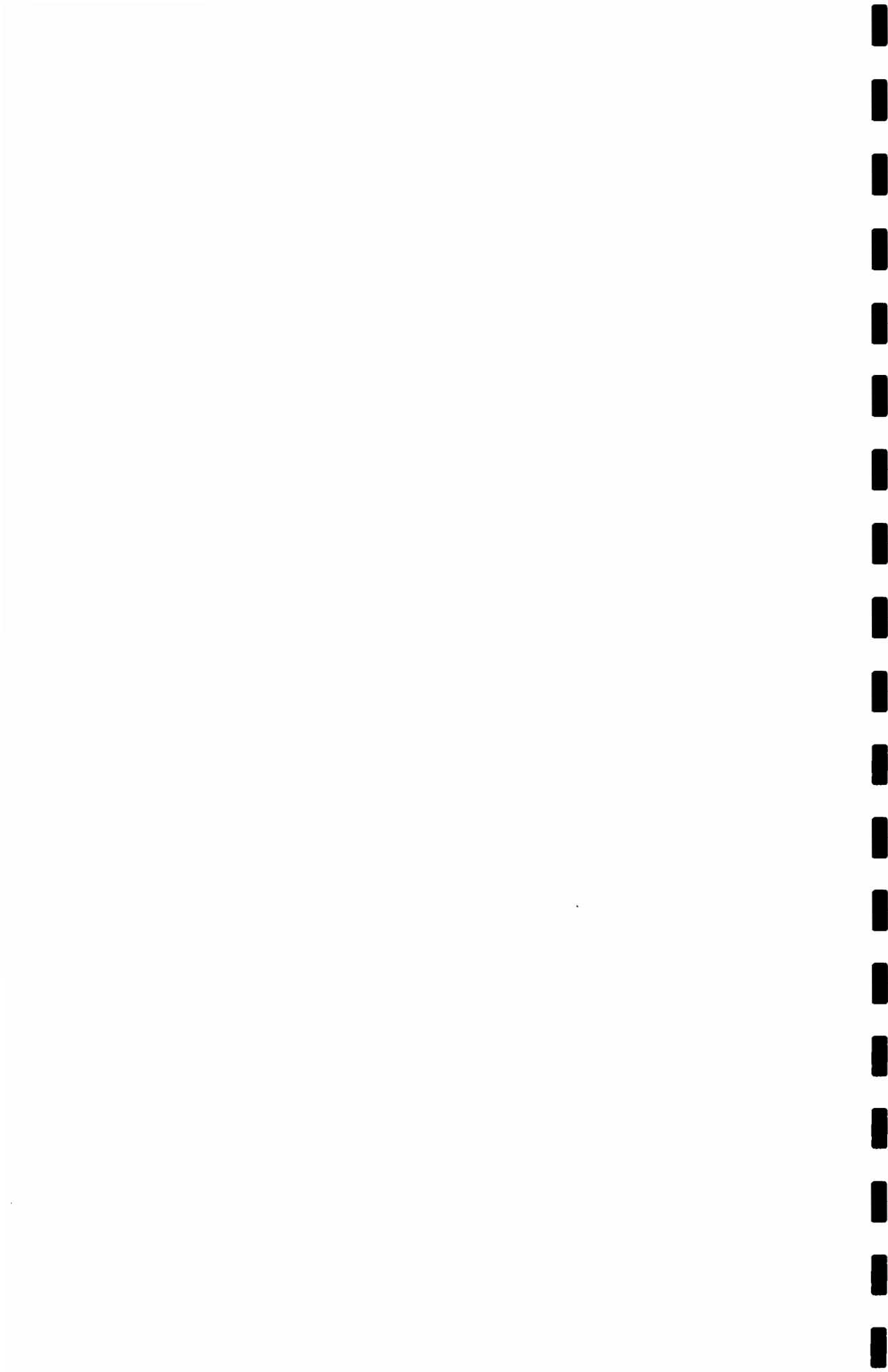
Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60					10-inch borehole to 119 ft. 8-inch borehole 119-130 ft.
70					
80				82' - 84' boulder	well yield approx. 20 gpm
				84'-98' clayey soil as above with trace amounts of rock fragments	
90					
100				98'-123' Dolostone - light buff to tan with seams of limonite up to 0.5" thick, occasional calcite seams and black dolostone, broken and weathered, becomes more competent around 116'	
110					
120				123'-130' clay and soft dolostone filled void	
130				128' Bottom of well 130' Bottom of borehole	

AR360417



Dunn Geoscience Corporation 2 Market Plaza Way, Mechanicsburg, PA 17055 (717) 795-8001				Test Boring/Well Construction Log			
Project : NGK Metals RFI						Boring No. MW-18	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Phase II RFI						Job No. 5756	
Drilling Contractor: Eichelberger				Driller : E. Funk		Total Depth 55.5'	
Geologist : J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 6/5/91	
Time Log: Begin Finish Depth				Casing	Steel	10"	Notes: 6" 020 slot pvc screen 55.5'-35.5' morie #1 qtz sand 55.5'-31', bentonite 31'-5', 10" steel well guard with locking cap
				Core			
				Well	PVC	6"	
				Sampler			
						Date Finished 6/7/91 S.W.L. 29.89 <u>TOC/GL</u> Elevation TOC Surface 332.33	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-0.5'				soil cover	
0.5'-13'				red mud	
13'-17'				c. gravel (qtzite), trace limestone gravel, wood pieces, glass, copper shavings	hard drilling
17'-20'				very coarse gravel, boulders	
20'-24'				gravel with sand, clay	
24'-35'				clay, sand and coarse gravel	
35'-49'				brown clay, sand and trace gravel	
49'-54'				severely weathered brown shale with dark grey limestone laminae	
54'-55.5'				competent medium grey limestone	final flow ~15-25 gpm
55.5'				bottom of hole	



Dunn Geoscience Corporation
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Test Boring/Well Construction Log

Project : NGK Metals RFI

Boring No. MW-19

Client : NGK Metals Corporation

Sheet 1 of 2

Purpose : Phase II RFI

Job No. 5756

Drilling Contractor: Eichelberger

Driller : E. Funk

Total Depth 65'

Geologist : J. Painter

Specifications

Type

Diameter

Hammer
Weight

lbs.

Date Started 6/7/91

Time Log:

Begin

Finish

Depth

Casing

Steel

10"

Notes: 6" 020 slot
pvc screen 65'-35',
more #1 qtz sand
65'-30.5', bentonite
30.5'-5', 10" steel
well guard with
locking cap

Date Finished 6/11/91

Core

S.W.L. 30.00

TOC/GL

Well

PVC

6"

Elevation TOC

Surface

Sampler

334.11

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-0.5'				soil cover	
0.5'-5'				red mud	
5-17'				c. gravel (qtzite)	
10					
17'-25'				very coarse gravel, boulders	
20				20'-24' gravel with sand, clay	
24'-40'				sand, gravel and clay	
30					
40				40'-60' gravel, sand and clay	
50					



Dunn Geoscience Corporation
 2 Market Plaza Way, Mechanicsburg, PA 17055
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Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-19

Client : NGK Metals Corporation

Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
60				60'-65' weathered brown shale, dark grey limestone	final flow ~50-60 gpm
61					
62				65' bottom of hole	
63					
64					
65					
66					
67					
68					
69					
70					
71					
72					
73					
74					
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Dunn Geoscience Corporation
 2 Market Plaza Way, Mechanicsburg, PA 17055
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Test Boring/Well Construction Log

Project : NGK Metals RFI							Boring No. MW-20		
Client : NGK Metals Corporation							Sheet 1 of 1		
Purpose : Phase II RFI							Job No. 5756		
Drilling Contractor: Eichelberger					Driller : E. Funk		Total Depth 52'		
Geologist : J. Painter				Specifications		Hammer		Date Started 6/11/91	
				Type	Diameter	Weight	lbs.		
Time Log:		Begin	Finish	Depth	Casing	Steel	10"		Notes: 6" 020 slot pvc screen 52'-32' morie #1 qtz sand 52'-29', bentonite 29'-5', 10" steel well guard with locking cap
					Core				
					Well	PVC	6"		
					Sampler				
				S.W.L. 32'		TOC/GL		Date Finished 6/13/91	
				Elevation		TOC	Surface		
				334.56					

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1'				soil cover	
1'-5'				red mud, metallic debris, slag and refractory	
5'-11'				gravel fill, some green staining	
11'-20'				fine to coarse gravel, boulders and sand	
20'-29'				gravel, sand and boulders	
29'-47'				sand and gravel	
47'-52'				medium to dark grey limestone, trace brown weathered shale	
52'				bottom of hole	
					final flow ~30 gpm

DUNN GEOSCIENCE CORPORATION

AR360421



Dunn Geoscience Corporation 2 Market Plaza Way, Mechanicsburg, PA 17055 (717) 795-8001				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>			
Project : NGK Metals RFI						Boring No. MW-21	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Phase II RFI						Job No. 5756	
Drilling Contractor: Boyles				Driller : Anderson		Total Depth 60'	
Geologist : J. Painter/ B. Heine				Specifications Type Diameter Hammer Weight lbs.		Date Started 3/19/91	
Time Log: Begin Finish Depth				Casing Steel 6"		Notes: 2" 010 slot pvc screen 60'-25' morie #1 qtz sand 60'-20', bentonite 20'-10', 6" steel well guard with locking cap	
				Core		Date Finished 3/25/91	
				Well PVC 2"		S.W.L. 24.10' TOC/GL	
				Sampler		Elevation TOC Surface 331.99 329.79	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0			[Pattern: Diagonal Lines]	0-3.5' overburden fill	
5			[Pattern: Horizontal Lines]	3.5'-10' medium grey limestone, 5% weathered brown, calcite veins	
10			[Pattern: Vertical Lines]	10'-26' light to medium grey limestone	
15			[Pattern: Horizontal Lines]		
20			[Pattern: Vertical Lines]		
25			[Pattern: Horizontal Lines]	26'-30' void	
30			[Pattern: Vertical Lines]	30'-31' clay seam	
35			[Pattern: Horizontal Lines]	31'-60' competent limestone	
40			[Pattern: Vertical Lines]		
45			[Pattern: Horizontal Lines]		
50			[Pattern: Vertical Lines]		
55			[Pattern: Horizontal Lines]		
60			[Pattern: Vertical Lines]	60' bottom of hole	final flow ~5 gpm



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Test Boring/Well Construction Log

Project : NGK Metals RFI

Boring No. MW-22

Client : NGK Metals Corporation

Sheet 1 of 2

Purpose : Phase II RFI

Job No. 5756

Drilling Contractor: Boyles

Driller : Robbins/Kelly

Total Depth 72'

Geologist : J. Painter

Specifications

Type

Diameter

Hammer
Weight

lbs.

Date Started 3/14/91

Time Log: Begin Finish Depth

Casing

Steel

8"

Notes: 4" 010 slot

pvc screen 72'-32'

more #1 qtz sand

72'-27.5', bentonite

27.5'-25', 8" steel

well guard with

locking cap

Date Finished 3/19/91

S.W.L. 27'

TOC/GL

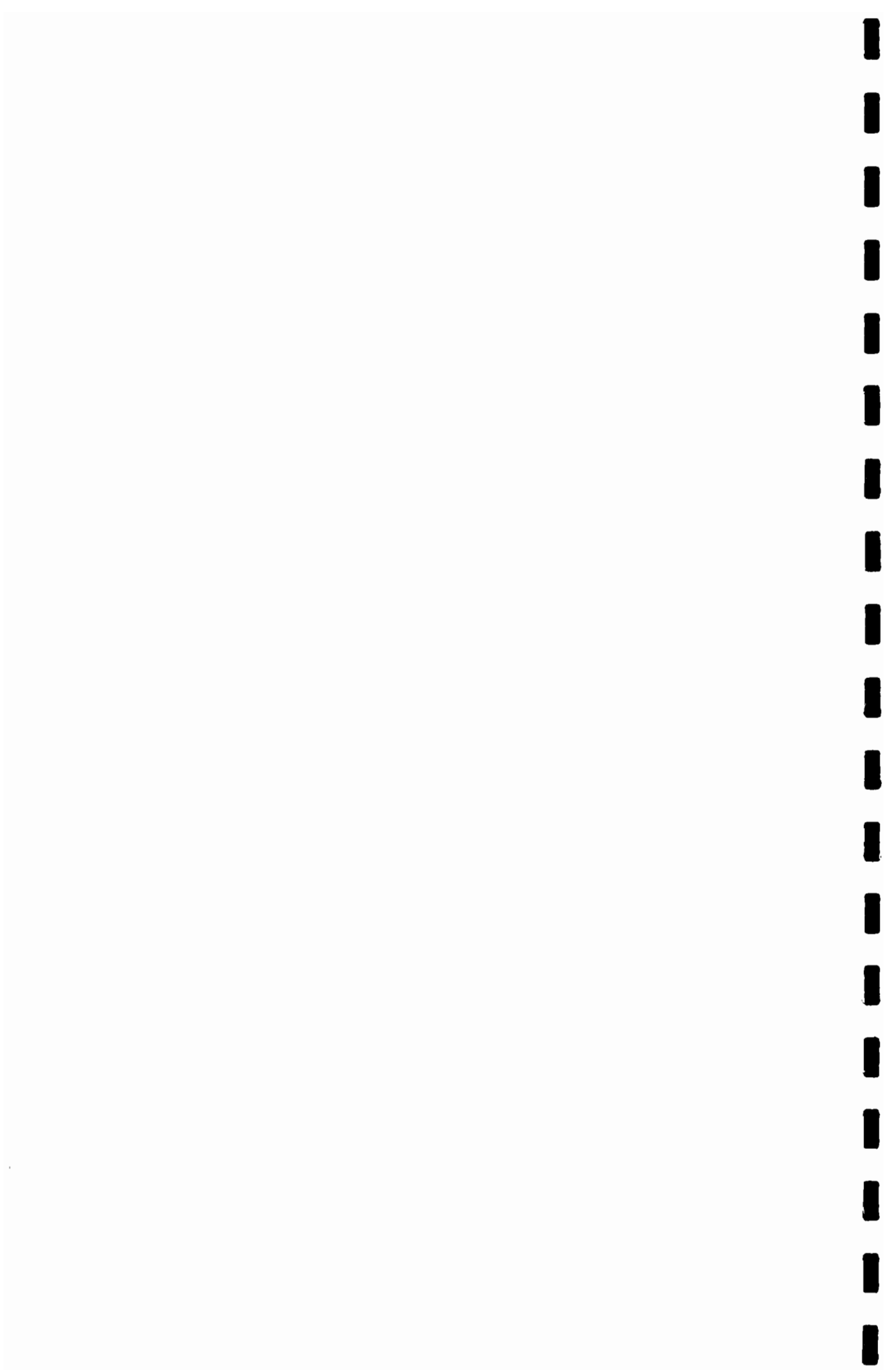
Elevation TOC

Surface

330.39

328.19

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1.5'				overburden gravel fill	
1.5'-2'				cinder fill	
2'-12'				light brown clay	4' dark grey limestone fragments
12'-14'				void	
14'- 57.5'				brown clay, severely weathered shale	



Test Boring/Well Construction

Boring No. MW-22

Sheet 2 of 2

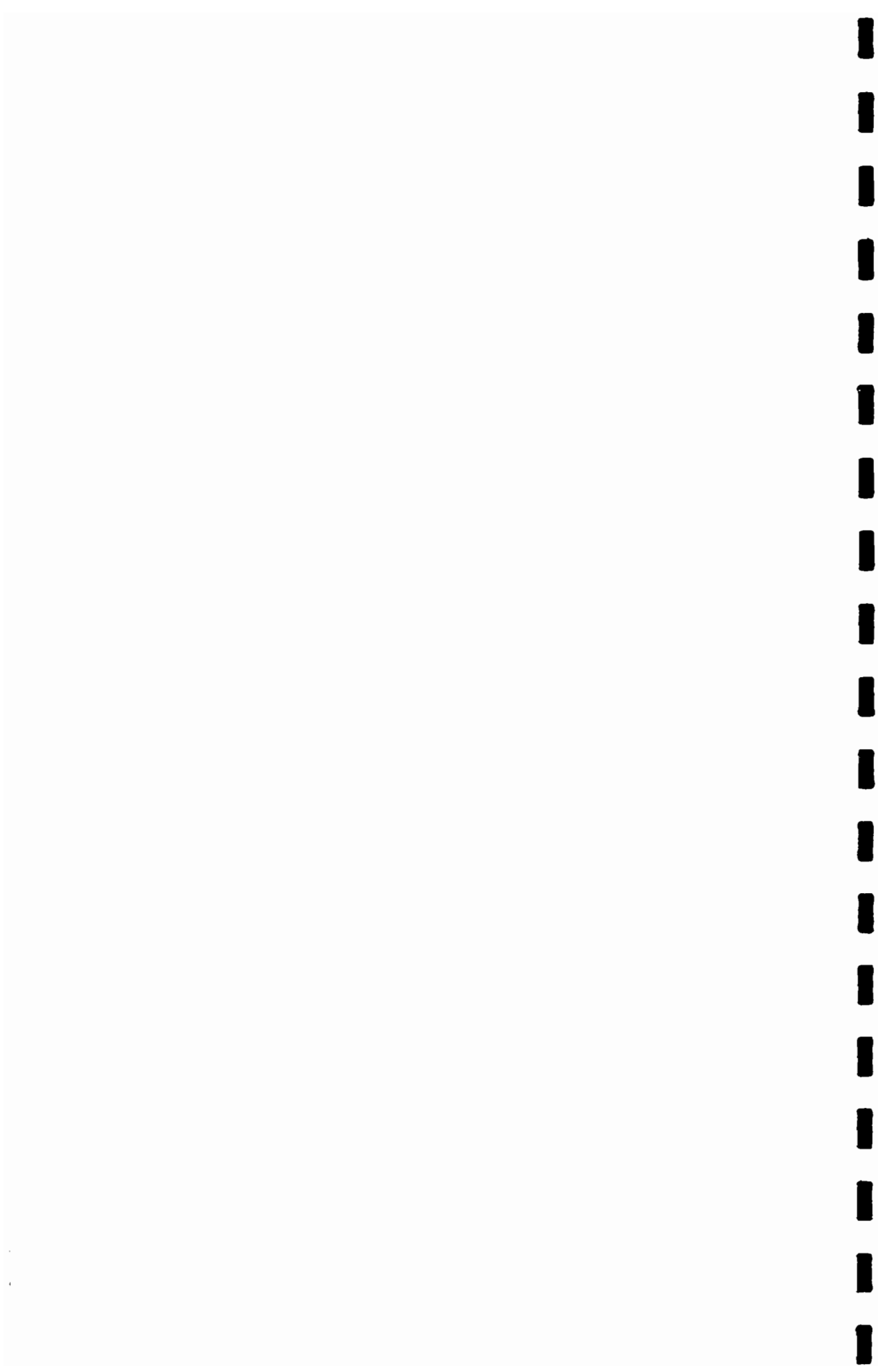
DUNN GEOSCIENCE CORPORATION

AR 360424



Dunn Geoscience Corporation 2 Market Plaza Way, Mechanicsburg, PA 17055 (717) 795-8001				Test Boring/Well Construction Log			
Project : NGK Metals RFI						Boring No. MW-23	
Client : NGK Metals Corporation						Sheet 1 of 2	
Purpose : Phase II RFI						Job No. 5756	
Drilling Contractor: Boyles				Driller : Anderson		Total Depth 73'	
Geologist : B. Heine				Specifications	Flammer	Date Started 3/19/91	
				Type	Diameter	Weight lbs.	
Time Log:	Begin	Finish	Depth	Casing	Manhole	8"	
				Core			
				Well	PVC	4"	
				Sampler			
Notes: 4" 010 slot pvc screen 73'-43' morie #1 qtz sand 73'-38', bentonite 38'-10', flush mount manhole well guard with locking cap						Date Finished 3/26/91 S.W.L. 34.10' TOC/GL Elevation TOC 327.27 Surface 327.27	

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1.5'				asphalt, bricks	
1.5'-2'				gravel fill	
2'-2.5'				red mud	
2.5'-3'				brick, concrete, rocks, steel fragments	
3'-4'				coarse gravel stained red	
4'-7'				red clay	
7'-8.5'				light to medium brown clay	
8.5'-29'				light yellow brown clay	
29'-39'				clay as above, 5% fine pebbles (1-3mm)	
39'-62'				orange-brown shale, soft	



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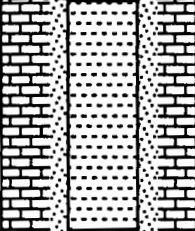
Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-23

Client : NGK Metals Corporation

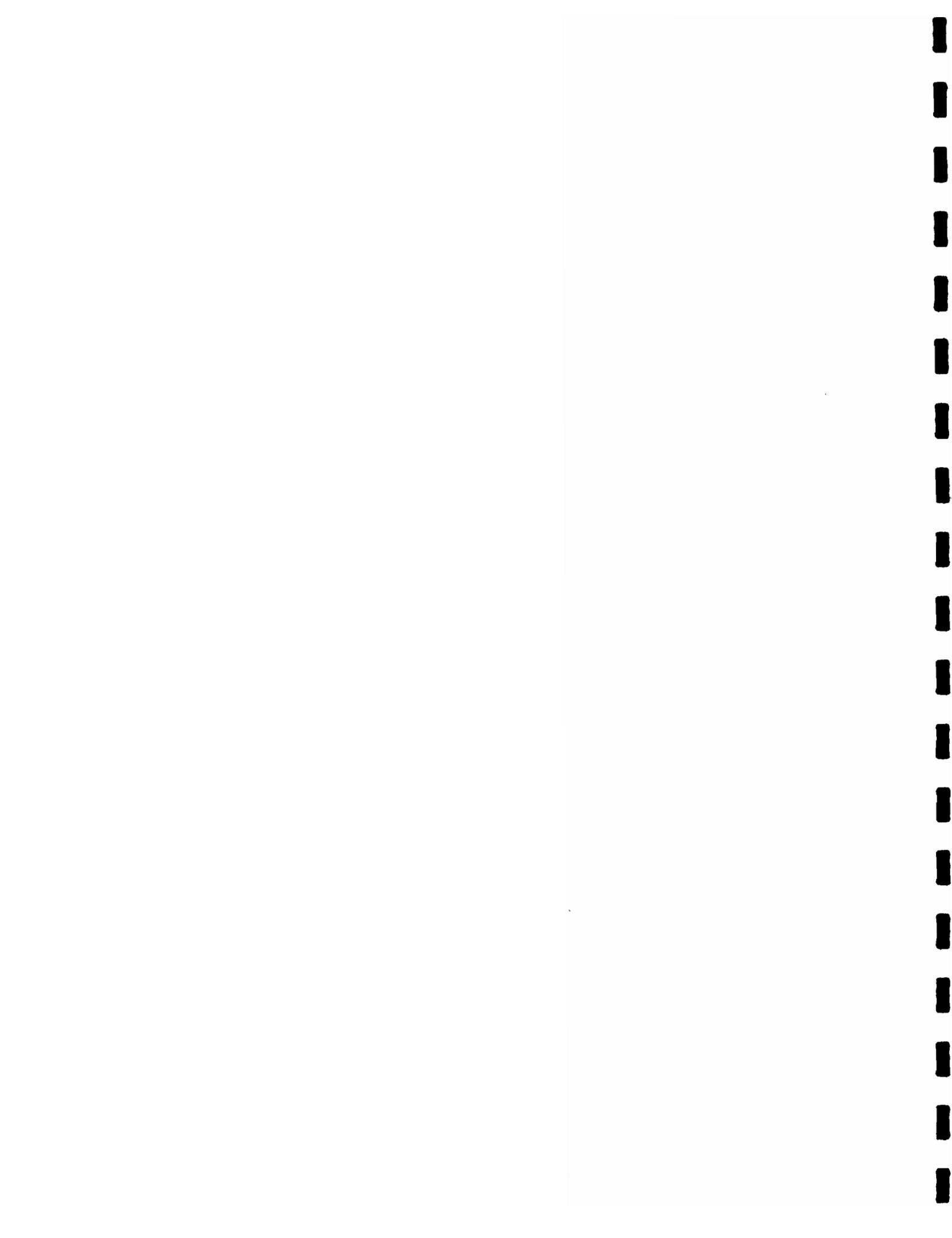
Sheet 2 of 2

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
62'-69'				dark grey limestone, weathered, fractured	
69'-74'				dark grey limestone, trace calcite veins, trace red staining, fractured red and gray shale chips	
74'				bottom of hole	final flow ~5 gpm
70					
80					
90					
100					
110					
120					
130					



Dunn Geoscience Corporation 2 Market Plaza Way, Mechanicsburg, PA 17055 (717) 795-8001				<h2 style="margin: 0;">Test Boring/Well Construction Log</h2>				
Project : NGK Metals RFI						Boring No. MW-24		
Client : NGK Metals Corporation						Sheet 1 of 2		
Purpose : Phase II RFI						Job No. 5756		
Drilling Contractor: Eichelberger				Driller : Brooks		Total Depth 63'		
Geologist : B. Heine/ J. Painter				Specifications		Date Started 4/1/91		
				Type	Diameter	Hammer Weight	lbs.	
Time Log: Begin Finish Depth				Casing	Manhole	8"	Notes: 4" 020 slot pvc screen 63'-33' morie #1 qtz sand 63'-30', bentonite 30'-2', flush mount manhole well guard with locking cap	
				Core				Date Finished 4/3/91
				Well	PVC	4"		S.W.L. 32' TOC/GL
				Sampler				Elevation TOC Surface 298.82 298.82

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
				0-5.5' sandy, silty loam 5.5'-10' boulder, coarse sand, gravel	
10				10'-15' fractured rock	
20				15'-20' buff to tan dolomite, interbedded with dark grey limestone, brown- orange mud with quartzite frag- ments, sand, breccia fragments, white dolomite 20'-22.5' fractured rock 22.5'-37' quartz fragments, sand, trace carbonate rock	
30				37'-46' clay seam, void	
40				46'-47.5' boulder, gravel 47.5'-57' clay	
50					



Test Boring/Well Construction

Boring No. MW-24

Sheet 2 of 2

AR360428





Dunn Geoscience Corporation
 2 Market Plaza Way, Mechanicsburg, PA 17055
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Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-25

Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes	
				63'-71'	light brown shale interbedded with grey dolomite	
70				71'-82'	competent rock as above grades to light brownish-grey to grey dolomite	
80				82'-148'	buff to light grey dolomite, oc- casional reddish brown sandy horizon, trace iron staining	
90						
100						
110						
120						
130						

DUNN GEOSCIENCE CORPORATION

AR360430



Dunn Geoscience Corporation
 2 Market Plaza Way, Mechanicsburg, PA 17055
 (717) 795-8001

Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-25

Client : NGK Metals Corporation

Sheet 3 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
150				148'-178' iron stained, weathered shale and dolomite, trace quartzite	148' flow increases
160					
170					
178'				bottom of hole	final flow ~ 15 gpm
180					
190					
200					
210					

DUNN GEOSCIENCE CORPORATION

AR360431





Dunn Geoscience Corporation
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Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-26

Client : NGK Metals Corporation

Sheet 2 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
70					
80					
90					
100					
110					
120					
130					

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Test Boring/Well Construction

Project : NGK Metals RFI

Boring No. MW-26

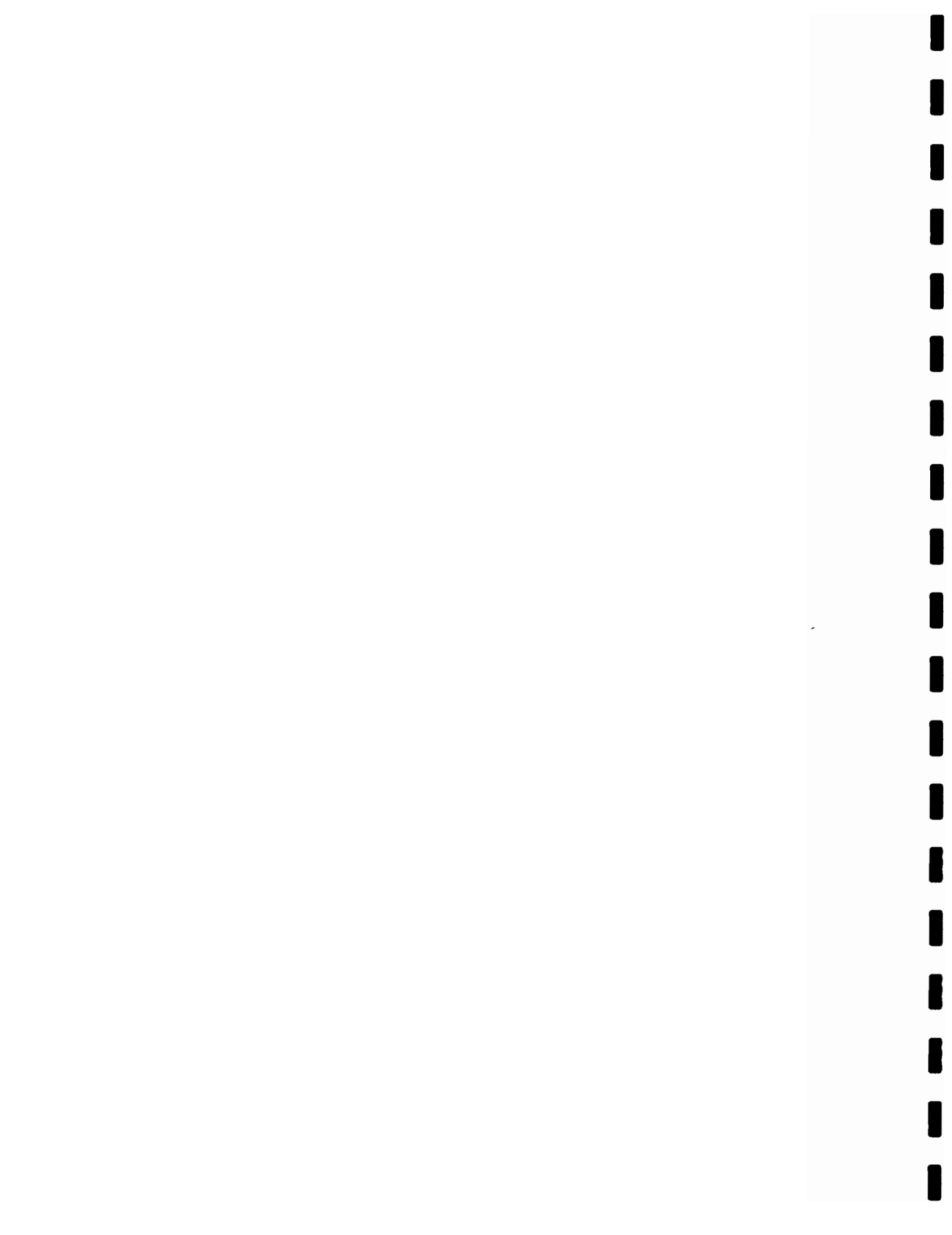
Client : NGK Metals Corporation

Sheet 3 of 3

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
150					
160					
170					
180				177'-202' light to medium grey limestone	
190					
200				202' bottom of hole	final flow ~3 gpm
210					

DUNN GEOSCIENCE CORPORATION

AR360434



Dunn Geoscience Corporation 2 Market Plaza Way, Mechanicsburg, PA 17055 (717) 795-8001				Test Boring/Well Construction Log			
Project : NGK Metals RFI						Boring No. P-1	
Client : NGK Metals Corporation						Sheet 1 of 1	
Purpose : Phase II RFI						Job No. 5756	
Drilling Contractor: Boyles				Driller :Kelly		Total Depth 45'	
Geologist : J. Painter				Specifications Type Diameter Hammer Weight lbs.		Date Started 3/19/91	
Time Log: Begin Finish Depth				Casing	Steel	4"	Notes: 2" 010 slot pvc screen 45'-30' morie #1 qtz sand 45'-28', bentonite 28'-27', 4" steel well guard with locking cap
				Core			
				Well	PVC	2"	
				Sampler			
						Date Finished 3/21/91	
						S.W.L. 32' TOC/GL	
						Elevation TOC	Surface
						302.35	300.55

Depth (Feet)	Sample Numbers	Blow Counts	Visual Log Description	Lithologic Description	Notes
0-1'				topsoil	
1'-3'				quartzite gravel and small boulders	
3'-6'				light brown silt, fine grained sand, pebbles	
6'-7.5'				boulders	
7.5'-8'				brown silty sand, quartzite gravel	
8'-11'				brown silt, sand	
11'-18'				gravel-subangular, brown silt	
18'-21.5'				light brown sand	
21.5'-24'				gravel	
24'-28'				light brown clay, fine grained sand	
28'-28.5'				gravel	
28.5'-42'				light brown clay, fine grained sand	
42'-45'				gravel	
45'				bottom of hole	final flow ~5 gpm

